ARCHIVES OF OTOLOGY.

ON THE HISTOLOGICAL ALTERATIONS OF THE LABYRINTH IN HEMORRHAGIC PACHYMENINGITIS (HÆMATOMA DURÆ MATRIS).

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(*With 25 illustrations on three double plates, I–VI.*)

WHILE the investigations of Manz * and Fürstner † have in many respects enlightened us as to the functions and anatomical disturbances of vision, we are almost without information in this direction regarding the organ of hearing. In the eye, both investigators found single or bilateral choked disk, exactly as in the case of tumors of the brain, and an effusion of blood either in one or in both sheaths of the optic nerve. Manz considers this hemorrhage to be caused by the forcing of blood, in consequence of increased intra-cranial pressure, into the optic nerve sheaths; Fürstner believes that, with due regard to the necessary caution, we could utilize diagnostically the relatively frequent *unilateral* occurrence of choked disk induced by the anatomical conditions of hemorrhagic pachymeningitis; because bilateral alterations of the fundus of the eye appear to be the rule, in the general, uniform increase of pressure by tumors, etc.

* Ueber Sehnervenerkrankung bei Gehirnleiden. *Deutsches Arch. f. Klin. Medicin.* Bd. ix, pp. 347, 348.

† Fürstner. Zur Genese und Symptomatologie der Pachymeningitis hæmorrhagica. *Arch. f. Psych. und Nervenkrankh'in.*, 1877.

Thus far we know nothing of the anatomical changes in the organ of hearing of persons who have suffered or died from hemorrhagic pachymeningitis, and as to the functional aural disturbances or perhaps objective demonstrations during life, the respective data are very defective. And yet the subject appears to me of importance in both directions.

I.—*Anatomically*, because recovery from the affection is still disputed, and because the finding of hemorrhages and their derivations, as they actually occur in the labyrinth, may be of interest to both parties—those who look upon the neomembrane formed by the inflammation of the dura mater as the *essential*, the *incipiency* of the process (Virchow,* Heschl,† Wagner,‡ Kremiansky§ Rindfleisch ‖) in the train of which ensued the hemorrhages from the newformed vessels; and also for those who declare the *extravasation of blood in planes* to be the *primary lesion*, the blood only after its organization becoming the matrix for the pathological process (more recently Huguénin,** preceded by Ramaer and Sperling).

II.—Regarding the *functional* disturbances, we can combat them effectually, if at all, only if we are enlightened as to the nature of the anatomical disturbances underlying them. The former might become subjects of diagnosis and therapeutics not only during the attack, but possibly after all threatening cerebral symptoms have subsided. For Griesinger†† says: "Hæmatoma of the dura mater is cur-

* De hæmatoma duræ matris. Verhandlungen der Würzburger phys. med. Gesellschaft, 1856.

† Compendium der pathol. Anatomie. Venice, 1855.

‡ *Archiv der Heilkunde.* 1860, p. 441.

§ Virchow's *Archiv*, Bd. xlii, pp. 129–161, and pp. 321–352.

‖ Pathol. Gewebelehre, 5th ed.

** In v. Ziemssen's Handbuch der spec. Pathologie und Therapie, Bd. xi. First half.

†† *Archiv der Heilk.*, 1862, p. 33, and Ges. Abhandl., Bd. i, p. 390, *et seq.*

a, p. 390 of Ges. Abhandl., Case 4. Recovery. By Bouillon Lagrange. *Arch. Gén.*, 1847, Bd. xiv, p. 313.

b. p. 391, *Ibid*, Case 8. Recovery. Textor. Würzburg. Verhandl., vii, 1857, p. 299, and Fuchs, Gehirnerweichung, 1838, p. 83. Fuchs had here enumerated the case as recovery from "softening of the brain."

c. p. 398, *Ibid.* Case of improvement, by Bamberger. Würzb. Verhandl. p. 300. Death from cholera 35 days after the attack.

able," fortifying his own observations with extensive proofs from literature; and Hasse* states: "It, however, seems as if at times an entirely harmless involution is possible of the products ascribed to the first and even the second period. In favor of this view, too, we have autopsies in which were found deposits upon the inner surface of the dura mater with which they more or less firmly connected, or could be detached from it as loosely adherent connective-tissue layers, and in which a new epithelial layer separated the whole from the arachnoid; while in other cases partial adhesions existed with the so-called visceral arachnoid."

The particulars of authors respecting the *functional disturbances of the organ of hearing* in hemorrhagic pachymeningitis are exceedingly meagre and defective. Among more than one hundred reports of cases which I examined with that view, in the treatises and articles of L. Rostan,† J. Abercrombie,‡ G. Andral,§ Bailarger,‖ Lelut,¶ Aubanel,** Prus,†† Melian,‡‡ Fr. Oesterlen,* Bouillon Lagrange,† Lecorché,‡ Ogle,§ Schuberg,‖ Griesinger,¶ and others, the symptomatology of the auditory organ is mentioned about

d. p. 398, *Ibid.* Case of possible recovery, by Prus. Mém. de l'Acad. de Méd., xi, 1845. Observation 13, p. 62. No autopsy.

In cases *a* and *b* the blood-sacs were found, in the one six months, in the other nine years after the disease.

* Handb. der spec. Pathologie, by Virchow, pp. 445 and 446.

† Recherches sur le ramollisement du cerveau, transl. by Fechner. Leipsic, 1824.

‡ Path. and Pract. Investigations of Disease of the Spinal Cord.

§ *Clinique Méd.* Paris. 1834.

‖ *Arch. Gén. de Méd.*, T. V., 2d series, 1834.

¶ *Gaz. Méd.*, 1836, No. 1.

** Parapoplexie. *Oest. Med. Wochenschr.*, 1844, No. 37.

†† Mém. sur les deux malad. connues sous le nom d'apopl. mén. Mém. de l'acad. de méd., 1845, T, xi.

‡‡ Des fausses membranes de l'arachnoïde, etc. *Annales Méd. Psych.* 1843.

* Canstatt. Jahresber., Bd. ii, p. 65, *et seq.*

† Arch. gén, 1847, Bd. xiv.

‡ Ramollisement multiples de la substance grise des cerveau. *Gaz., Méd.* 1856, No. 49.

§ *Arch. of Med.*, vol. i, p. 277, and vol. ii, p. 85, and Schmidt's *Jahrb.*, Bd. cxii, p. 162.

‖ Virchow's *Archiv*, Bd. xvi, pp. 464–512.

¶ L. c., see above.

five times, and then but cursorily. So, for instance, Ogle reports fifteen autopsies with twelve cases, in which the organ is not mentioned at all. Griesinger, in his experience —he gives a review of eight cases—says simply, "No otorhœa." Abercrombie, in his sixth observation, speaks of continuous ringing in the ears and vertigo, which might as well be due to the cerebral affection as to the ear. Andral (*l. c.*, p. 11) mentions *vertiges et tintements* (vertigo and tinnitus) in his third observation. In Bouillon Lagrange's observations, head and ear were the seat of rather strong and at times very annoying knocking.* Some authors (comp. Oesterlen, l. c.) also mention *hallucinations of hearing*, both as precursors and as symptoms of the affection.

The proportionately rare mention of auditory disturbances in hemorrhagic pachymeningitis (about 5 per cent.) is, however, absolutely no proof that they are of rare occurrence in reality. For, in the first place, in not a single case is there a mention of an objective examination made, or even a functional test; in the second place, we must consider that we have to deal with an affection in which memory, intelligence, the power of controlling the sensory perceptions, etc., of the patients are often in the highest degree disturbed—that they not rarely get under medical treatment in a state of stupor or sopor, so that it is often absolutely impossible to judge of the acuteness of hearing, and the presence of subjective auditory perceptions cannot be determined.

Desirous of making a careful anatomical examination of the auditory organ of a person who had died from hemorrhagic pachymeningitis, I applied to my esteemed friend and colleague, Dr. Cramer, Professor of psychiatrics at Marburg, who, in September, 1878, sent me two such petrous

* "Le malade (æt. 75), naturellement un peu sourd, l'est beaucoup plus depuis qu'il est ainsi plus souffrant." (The case was still more complicated, inasmuch as the patient during horseback riding lost one of his stirrups, and, suspended from the horse by the other, was dragged a distance of 200 metres, and later was dashed to the ground.) "La tête et les oreilles sont le siège de battements assez forts et pénibles parfois." Six months after complete recovery he was murdered. In the report of the autopsy nothing further is said about the ear than that on moving the skull blood flows from the right nostril and the right ear, and that the interior jugular vein and left carotid were lacerated within the petrous bone, this, however, has reference to the violent manner of death.

bones (in Müller's fluid), together with the history of the patient who had died at the lunatic asylum at Marburg. The history was furnished by Dr. Siemens. To both gentlemen I hereby beg to tender my thanks.

CASE.—G. M., forest official, æt. 47, was admitted to the Marburg lunatic asylum on June 9, 1876. (Said to be free from inherited taint, to have passed through a normal youth, then to have became forester, and to have married as such. Has five children.) As early as eighteen months before his admission, depression with excitements is said to have existed, which gradually passed into stupor. Since January, 1876, in the County Hospital of Cassel, he was transferred to Marburg in June.

The patient was a rather tall, strongly built, and tolerably well-nourished man, slightly bald, with dark-blond hair and full beard; iris blue, pupils moderately and mostly equally dilated. Teeth defective; on laughing and speaking, patient opened the mouth wide; the expression of the face generally was good-natured, indifferent, weak minded; therewith he often exhibited a kind patronizing smile and nod. His speech sounded as if the palate were not closing well, and a defective mobility of the velum palati really existed. The speech was slow, muttering, the R being particularly indistinct, but there was no stammering. These conditions remained constant until death. The skin in general was pale, without œdema. Here and there superficial cutaneous abscesses formed. The organs of the well-formed thorax showed no abnormalities on physical examination, only at the heart the first sound over the atrio-ventricular valve was divided. Pulse regular, of fair quality, quiet. Abdominal organs normal; appetite always greatly increased.

Sleep at first was quiet and good. Graver disturbances of sensibility and motility were not observed at first, no visual disturbances, but there were *hallucinations of hearing*. Patient often addressed the ceiling: "They call me above, my bride is up there, she always hovers over me!" "I hear everything exactly, I see into the whole world, I see everything!" As to his other psychic condition, he displayed the imbecile idea of exaltation common to paralytics—he owned castles, large forests, was of high birth, etc. Withal he was mostly unaffected, sociable, amicable, harmless, and always very polite. He paid his compliments with a serious *grandezza* or a patronizing smile; the way in which he accepted a

proffered cigar, had it cut, and lighted it, and then thanked for it, was faultless and remained so even until all other higher mental faculties had been obliterated.

The measurements of the head were :

Transverse diameter	14.2 cm.
Longitudinal "	19.8 "
Circumferance	56. "
Length of face	12.2 "

In this manner, without material occurrences, he passed several months in the institution, generally known as " the high forester," on account of his noble deportment.

On August 30th, the first paralytic attack occurred, while the patient was at stool. It resembled syncope, cramps did not appear, consciousness remained clouded for some time, after reflexes had already reappeared, and volitional motility also returned. The next day patient again felt quite well, only his speech, and all motions and manifestations generally, had become much slower and more awkward, AND HIS HEARING WAS MUCH WORSE THAN BEFORE.

The second paralytic attack ensued on October 14th, a more anxious mood having meantime taken possession of the patient—the fear of being poisoned ; there occurred short loss of consciousness, paresis of the left side. The tongue deviates slightly to the right. Pupils equal. Sensibility on the entire left side reduced, deglutition difficult, speech incomprehensible, mumbling. The patient during the next day again acquires more motility, is very restless, continually moving arms and legs, toward noon clonic spasms occur. The head was always turned to the right. This condition, with remission of the spasms, continued several days, gradually the symptoms improved, and by the beginning of November he again walked about, the left side being still somewhat weaker than the right ; THE IMPAIRMENT OF HEARING HAS INCREASED. At this time the patient at night was often restless and unclean, later but seldom.

This fair condition remained until April, the weight increased from 148 to 160 pounds. In spring and summer two more paralytic attacks occurred, both passing quickly. An ophthalmoscopic examination showed on both sides obliteration of the outlines and injection of the optic papilla (*choked disk*). *In July, 1877, hearing seemed to have completely disappeared.*

The mental functions now rapidly deteriorated, patient became quite stupid, indifferent, continually grinding his teeth and nodding iodiotically to himself. In October again an attack of weakness, causing him to drop. During the winter he was mostly restless at night, began to tear everything, and grew very unclean. Sensibility appeared more and more impaired, while motility continued fair. His weight in April, 1878, was only 128 pounds. In June, 1878, rhythmical tremors of the muscles of the right side again recurred, but soon disappeared. Patient often beat his head with his flat hand, as if he had headache. He now declined more and more, had to be fed, was always very unclean, and finally succumbed to bed-sores and marasmus (August 18, 1878).

The autopsy (August 19, 9 A.M.), which furnished but little of interest in the rest of the body, yielded the following data from the dissection of the head: *Vault of the skull*, smooth within and without, but greatly thickened; *dura mater* firmly adheres to it; on opening the subdural space, a considerable quantity (about 200 *cm.*) of yellowish serum is discharged.

On the inner surface of the dura mater, there are, over both cerebral hemispheres, stratified, but in general not very thick, pale-gray pseudomembranes, free from hemorrhagic deposits. They inclosed, bag-like, a large quantity of fluid, part of which had escaped, but some of which was still remaining on the cerebral hemispheres.* The *pia mater* above the latter was opacified and thickened, the convolutions flattened, and the cerebral hemispheres, throughout their entire length, but especially at the part corresponding to the convex side of the anterior brain, were atrophied or compressed by the pressure of the fluid. The lateral ventricles, and other cerebral cavities, likewise contained much serum. The *brain substance* was firm, particularly the ependyma of the ventricles felt hard on cutting; there were no granulations on the latter, excepting a trace on the floor of the fourth ventricle. The large cerebral ganglia showed nothing exceptional. The basal vessels of the brain were in a state of slight atheromatous degeneration. The weight of the entire brain amounted only to 890 grms.

*Of course, we here had a hæmatoma of the dura mater, the contents of which, in the course of time, had been transformed into serous fluid. Such cases have long been described by Virchow.

CONDITIONS OF THE TWO PETROUS BONES PRESERVED IN MÜLLER'S FLUID.

A. BEFORE DECALCIFICATION.

External and Middle Ears.

Right Petrous Bone.—Much pus in the external auditory meatus; large central perforation of the drumhead. The rest of the membrana tympani is thickened; grayish-red. Manubrium mallei retracted. At the upper margin of the posterior remnant of the membrana tympani there is a granulation springing from the posterior section of the drum cavity. Tube normal. The mucous membrane of the malleo-incudal joint, of the antrum, and of the promontory is thickened. The above-described granulation originated in the antrum. Plate of stapes movable.

The microscopic examination of transverse sections of the thickened mucosa of the promontory showed: in the superficial layers, villous; below, more horizontally extending proliferations of connective tissue; both layers interspersed with round cells, decreasing in number from the surface inferiorly. Below, the fibrous formation is less marked; the tissue consists partly of spindle-shaped, partly of pale, finely granular, large, cellular formations connecting by off-shoots with band-like fibres of the proliferated layers of the connective tissue.

Left Petrous Bone.—Membrana tympani retracted in funnel shape, its mucous surface strongly opacified, especially at the periphery. Tube normal. The mucosa of the entire middle ear thickened. Incus dislocated during the preparation, plate of stapes movable.

B. AFTER DECALCIFICATION.

In order to proceed with certainty in the investigation of the histological alterations of the labyrinth, I requested Professor Waldeyer to indicate to me a reliable method adapted to the individuality of my case. He at once complied with my request by the following communica-

tions, for which I offer my thanks, and which I here copy *verbatim*, in the interest of the subject:

"One petrous bone, of which only the unnecessary osseous and soft parts are removed, is put entire into chromic acid 1 part to 600 parts of water; a few days later in chromic acid 1 : 400, and again in a few days, in chromic acid 1 : 200. To the latter mixture added, for each 100 cubic centimetres of fluid, 2 cubic centimetres of officinal (Germ. Pharm.) nitric acid, for the purpose of hastening the decalcification. If sufficiently decalcified, a single, rapid rinsing in water, then the preparation is immersed for three or four hours in about 80 per cent. alcohol. This is succeeded by thorough washing in running water for about 6 hours in order to remove all acid possible, then the preparation is again immersed in 80-90 per cent. alcohol for at least 24 hours. Then follows examination of sections. Staining may be performed either with carmine or hæmatoxylin as usual.

"The other petrous bone is taken from Müller's fluid, washed with distilled water, and labyrinth and cochlea opened at several places. Osseous and soft parts are removed as far as possible. During this process the preparation must not be allowed to become dry. It is then placed during the night, about 10-12 hours, in a two-per-cent. solution of osmic acid. Aurum chloride would not appear suitable after a prolonged immersion in Müller's fluid. It should now be decided if teazed preparations (in glycerine) or sections are to be made. In the former case, I would remove the respective portions (cochlea, etc.) and preserve them in a concentrated solution of acetate of potassium or else in glycerine, and teaze them moistened with these fluids at leisure. For sections, the treatment with osmic acid should be followed by a rapid washing in water, then by immersion in alcohol of 80-90 per cent. for 24 hours, and finally the same process of decalcification as above described.

"Palladium chloride with hydrochloric acid acts well only with small objects. Picric acid (concentrated) may also be tried, but it acts slowly."

Regarding this method a discussion took place in the

otiatric section at the meeting of German naturalists and physicians at Baden, which led to a second verbal question of Professor Waldeyer, who thus expressed himself to Gottstein: "*First hardening, and then decalcification,*"

For the purpose of being enabled to form an independent opinion I have employed both methods: the right petrous bone was treated and examined according to the first; the left, according to the second method with osmic acid. After I had treated the left petrous bone for two months according to Waldeyer's method of decalcification, I tried to make sections but still found it resistant; the (certainly very rare) cause being an *enostosis* (?) in the internal auditory meatus, reported on below. In the right petrous bone nothing of that nature was encountered, and after two months of decalcification good sections could be cut without difficulty.

Regarding other methods or re-agents the application of which was found necessary or appropriate in the course of the examination I shall likewise here give the essential data. As my later communications will show, there occurred, among others, also manifold atrophic processes in the nerves, and as Waldeyer remarked above, since the otherwise reliable aurum chloride was of no service in preparations which had long lain in Müller's solution, I employed with advantage the re-agents indicated by Treitel.* According to this writer, *fuchsine, aniline-blue* and the *iodine-violet*† recommended by Jürgens (Virchow's *Archiv.*, Bd. xxv, p. 189) stain the *medullary* nerve substance *very intensely*, while they color the degenerated nerves much more faintly, and the connective tissue not at all. For purposes of comparison carmine may also be employed, which stains the atrophic nerve substance bright red, while the medulla does not take any color. The normal portions, therefore, distinguish themselves plainly by lack of color from the reddened atrophic parts (Leber).

* On a new Reaction of the Medullary Nerve-fibres. By Dr. Th. Treitel. *Med. Centralbl.*, 1876, No. 9.

† Called also methyl-violet or Leonhardt's ink; it is commendable for examinations like the present, particularly because it stains the amyloid a beautiful and luminous red, while ordinary cellular substances, etc., are dyed an intense blue. (Comp. J. Cohnheim: *Allgem. Pathologie,*" Berlin, 1877, p. 569.)

HISTOLOGICAL INTRODUCTORY REMARKS.

In order to facilitate to the reader the comprehension of the succeeding pathological results, I shall give a short synopsis of the current views as to the histological composition of the membranous structures within the labyrinth.

According to Henle,* its periosteum is of very slight thickness. It consists of very delicate, reticular fibrous layers, the structure of which resembles the tissue of the suprachoroid. The lacunæ of the mesh-work tissue contain flat, round, or elliptical nuclei, at times in such quantity and regularity as to resemble the nuclei of an epithelium; but an epithelium of really isolated cells does not, according to Henle, Hasse, and others, occur in this situation, least of all in the vestibule and the semicircular canals, from the periosteum of which numerous thin fibres and blood-vessels extend to the external surface of the corresponding structures of the membranous labyrinth.

The periosteum of the labyrinth resembles the supra choroid also by being interspersed with the stellate pigment--cells in varying numbers.

The connection of the membranous canal with the periosteum of the osseous canal takes up proportionately but a a narrow stripe of the latter; but connective-tissue trabeculæ, conducting vessels into the membranous canal pass through the angle formed by the membranous canal on both sides of its attachment to the osseous canal, and also from the more remote portions of the wall of the osseous canal delicate vascular strings often traverse the perilymph in their course to the outside of the membranous canal (Rüdinger).

Henle, like other authors, distinguishes three layers on the membranous part of the semicircular canals, etc.:

The most external, forming at the same time the essential part of the wall, is called *propria* by Henle. Rüdinger† terms it: *stratum of connective tissue, also external fibrous layer;* it consists of the same reticular and nucleated fibrous

* *Sinnesorgane*, 2d ed., p. 808, et seq.

† Stricker's *Gewebelehre*, Häutiges Labyrinth, p. 383, et seq.

tissue which constitutes the periosteum and is traversed by blood-vessels which enter by way of the otherwise smooth surface of the passage. The second layer is denominated *basal membrane* by Henle; it is visible (solely) on cross sections as a narrow bright streak. Rüdinger calls this layer *propria*, and describes it as of glassy appearance, hyaline in the fresh condition, after the application of re-agents of a granular, slightly striped quality.

The interior surface of the semicircular canal is covered by the third layer—a simple *pavement epithelium* of hexagonal cells closely surrounding the nucleus.

As *fourth* layer of tissue of the semicircular canals, Rüdinger yet distinguishes the *papillæ*, or villous projections on the interior surface of his membrana propria. They are sessile on the latter, with broad base, and project in varying form into the lumen of the canal; they form an integral part of the propria, from which they are not distinctly limited. The structure of both is the same. The portion of the membranous semicircular canal which adjoins the bone is free from villi, the interior surface of which is invested with a single layer of pavement epithelium of irregular form.*

In a pathological direction, the *ligamenta labyrinthi canaliculorum et sacculorum*, as Rüdinger terms them, require still a special consideration.

According to his statement, the membranous semicircular canals are fastened by them to the periosteum of the bony canals. They consist of strong bands of connective tissue, which leave between them interstices of varying shape, appearing on sections as canaliculi running along the large membranous canal in the ligaments, and are encountered as far as the *neighborhood* of the ampullæ. According to Rüdinger, these fastenings are also present on the sacculi and ampullæ, but slightly developed in those angles

* In the difference of opinion existing between Lucæ (Virchow's *Archiv*, Bd. xxix, pp. 35 and 54) and Rüdinger regarding the constant occurrence of villi as well as their investment with epithelium, from personal observation I side with Rüdinger, provided that they do not refer to objects of different nature, as Henle suggests. The appearances described by Rüdinger are normal, not pathological. In order to prevent misunderstanding, I would here also state that I have employed Rüdinger's nomenclature of the three layers.

where the sacculi diverge from the bone. On cross-sections, vessels are also constantly found in the ligaments. Besides the above-described fibres of the external layer of the hollow formations, Rüdinger observed, in the surroundings of the vessels, and described another fibrous network, regarding the interpretation of which he still was in doubt. "Pale-looking, rather broad fibrous bands, are in regular reticular communication with each other. At the nodal points, where they become considerably broader, and where their fibrous character becomes more distinct, large cells, together with nuclei, are embedded in varying numbers. On first viewing it, this network makes exactly the impression of *nerves* with embedded ganglion-cells" (l. c., p. 889). But the question as to the importance of the formations described is left undecided by Rüdinger.

To the preceding I will add a few supplements, derived from normal human preparations made by Dr. Steinbrügge. For some of them the reader may consult Fig. 4, plate iii, and Fig. 6, plate i, although they partially represent pathological conditions.

All the so-called ligamenta labyrinthi have a fibrillary structure, and are surrounded at times with more, at times with less cells; the ligaments of the ampullæ more so than those of the semicircular canals. On cross-sections (comp. Fig. 4, *a*) these cells sometimes appear roundish, sometimes oval or pear-shaped, with a strongly granulated nucleus reaching nearly to the cell-wall. Between the meshes of the offshoots of the ampullary ligaments we often, besides, find larger, mostly round, now and then oval, cells with a centrally situated vesicular nucleus; contents of nucleus and cell are homogeneous; they are also met with in the interstices of the ampullary ligaments beside so-called plasma-cells, and a homogenous, finely granular, protoplasmoid substance, which probably is nothing but the perilymph coagulated *post-mortem* in the interstices of the canaliculi. On the other hand, cells do not occur, in the normal condition, in the inner ampullary layer of connective tissue which borders immediately on the membrana propria. The interstices previously mentioned are still

more frequent on the ampullæ than on the semicircular canals, because the wall of the ampulla is nowhere free, but everywhere fastened by the so-called ligaments. Fig. 6 shows them in the region of the crista of the ampullæ.

Regarding the middle layer of the membranous hollow structures, it should be added that, while it is homogeneous in the semicircular canals, the membrana propria of the ampullæ has oval nuclei (on cross sections).* The fibrous striation of the ampullary membrana propria is also much more pronounced, on equal treatment with reagents, than on the semircular canals. Finally, also, papillæ are found at the place of attachment of the semicircular canal, and some may be found even in the first part of the ampullæ.

Regarding the remaining details of the histology of the membranous hollow structures in the labyrinth, especially the manifold disputed conditions of the nerve terminations in the crista and macula, the reader is referred to Henle and Rüdinger.

DESCRIPTION OF THE PATHOLOGICAL CONDITIONS IN THE LABYRINTH.

Hemorrhages.

I have *not observed* any *macroscopically visible hemorrhages*, such as have been found and described by Manz and Fürstner in hemorrhagic pachymeningitis between the sheath and the trunk of the optic nerve. Nor could I demonstrate anywhere, what may occasionally be perceived in labyrinthine hemorrhages,† a rust-colored appearance in the respective passages and cavities, or in their membranous parts; neither upon the lining of the porus acusticus internus, nor upon the periosteum of the vestibule or the

* Kölliker, who assumed essentially the same structure of the membranous semicircular and ampullary hollow structures of the labyrinth, emphasized the presence of nuclei in the middle layer of the semicircular canals, which was denied by C. Utz (*Histologie der haütigen Bogengänge*, Munich, 1875) and Rüdinger.

† A detailed description of such a condition of the labyrinth, in a case of gun-shot wound of the ear, I have given in the ARCHIVES OF OPHTHALMOLOGY AND OTOLOGY, vol. ii, part i, p. 343.

cochlea, nor upon the lamina spiralis memb., the sacculi, the membranous semicircular canals or the ampullæ. On the other hand, there were present, nearly throughout the entire labyrinth, but in the left petrous bone more than in the right, now smaller, then larger, *microscopically visible extravasations of blood*, irregular hemorrhagic infiltrations, following partly the course of the veins, partly that of the bundles of nerve fibres; especially distinct upon the lining of the porus acusticus internus, on the external wall of the utriculus, in the so-called canal of Rosenthal, between the layers of the lamina spiralis ossea (on the left most considerable); moreover, between the vas spirale and the zona dentata (left), further upon the external wall of one ampulla right, and between the nerve bundles of its crista, and, finally, upon the external wall of the membranous left frontal semicircular canal.

Pigment-Metamorphosis of the Extravasations of Blood.

(See Plate II, Figs. 18, 19, 24 and 25.)

I could gain some information as to the *modus of the resorption* of extravasated blood. This varied in the separate regions of the labyrinth. In the connective-tissue layer of the semicircular canals and their ampullæ it was different from the membrana basilaris of the cochlea.

In the first-named region could be demonstrated both the *intra-cellular* metamorphosis of the red blood-corpuscles described by Langhans,* and that depicted by J. Arnold † in his experiments on diapedesis.

The *intra-cellular* transformation of the red blood-corpuscles manifested itself partly by brownish-red colored, multinuclear, finely granular round-cells, conveying the impression of lymphoid cells which had absorbed blood-corpuscles and changed their pigment, partly by contractile cells having one to three processes, with contents showing the most widely varying stages of pigment-metamorphosis.

* Beobachtungen über Resorption von Exsudaten und Pigmentbildung in denselben. Virchow's *Archiv*, Bd. xlix, p. 66.

† Ueber Diapedesis. *Ibid*, Bd. lviii, p. 231.

In favor of Arnold's modus of absorption we have the presence of partly single, partly aggregated, roundish or oval, yellow or yellowish-red colored, smaller and larger pigment-bodies, often containing, besides, black granules and grains; those in groups had a mulberry-like appearance, and made the impression of cells containing blood-corpusles: they were, however, not inclosed in a separate membrane, their outline was formed rather by the coalescing margins of the single blood-corpuscles entering into a group.

Besides, there were occasionally visible dark-brown colored granular masses which still inclosed some blood-corpuscles; here we probably had to deal with a *granular disintegration of single red blood-corpuscles.*

The demonstration that the lymph-channels may likewise take part in the absorption of extravasations of blood could be furnished from the condition of the basal membrane of both cochleæ. Here were found both a perivascular lymph-space filled with pigment, and club-shaped and cactus-like formed structures which were connected with each other and contained pigment; these formations were situated either immediately adjoining the wall of the blood-vessel or —very numerously—isolated, *i.e.*, without any direct vicinity to blood-vessels. The fact that some of the latter were not entirely filled with pigment, but contained in their interior a still clear space inclosing several lymph-corpuscles, is against the conjecture that some of the formations represented in Fig. 25 were perhaps simply tubes resembling normal, pigment-bearing lymphatics which had been hitherto overlooked.

For the present it remained undecided whether, in this condition, we had to deal with extravasated blood-corpuscles which had again migrated into lymph-spaces and had undergone a pigment-metamorphosis within the lymphatic vessels; but, according to the experimental investigations into diapedesis by J. Arnold (l. c., p. 253); this is very probable.

Arnold's experiments demonstrate with certainty that "we must not designate the blood-channels as efferent passages for exuded red blood-corpuscles; we are perhaps

much rather justified in awarding this rôle to the lymph-channels." In favor of this view Arnold asserts that the changes of position and grouping together of the exuded blood-corpuscles described by him most probably occur in preëxisting fissures and lacunæ of the tissue, and further, the presence of pigmented formations in the blood-channels regarding which the assumption only is possible that they reached the vascular system by way of the lymph-channels. The investigations published subsequently by Arnold * give additional support to this view, showing, as they do, that blood and lymph vessels represent independent systems between which the plasmatic channels are intercalated, and that these connect with both at the place of the so-called cement-ridges (Kittleisten) of the endothelial cells. Accordingly, for the proper understanding of the condition depicted in Fig. 24, we might assume that the plasmatic channels of the tissue undertook the rôle of transmitters, in the conduction into the lymph-channels of the extravasated blood or its coloring-matter transformed into pigment.

Condition of the Pigment failing to be re-absorbed.

(See Plate ii, Fig. 1; Plate i, Figs. 2, 3, 6, 7, and Plate i, Figs. 9 and 14.)

Position.—It was found mostly immediately adjoining the blood-vessels, at times also at a distance from them, sometimes in the adventitial sheath; exceptionally within the lymph-cavities; also along the perineurium of the nerve-fasciculi in the porus acusticus and the lamina spiralis ossea, and between the terminal nerve-fibres of the crista, where, in some preparations, the pigment infiltration extended between the basal cells.

In the cochlea, beyond the place of entrance of the nerves, *pathological* pigment could be demonstrated with certainty only in the basilary membrane (see above); otherwise, the greatest part was found between the layers of the lamina spiralis ossea and in the canal of Rosenthal. Among the

* Zur Kenntniss der Saftbahnen des Bindegewebes, Virchow's *Archiv*, Bd. xlviii, p. 465.

separate layers of the membranous hollow formations of the labyrinth, the connective-tissue layer contained the most, the membrana propria, the least; the mean between the two, in this respect, is held by the epithelial layer. Many epithelia of the semicircular canals showed no nuclei, but pigment infiltration with uncolored walls, and when the nucleus was still preserved, it was at times colored, at times not.

The color of the pigment was mostly light-yellow or brownish yellow, occasionally brownish-red and reddish, once brick-red (probably free hæmoglobin), also black.

Form.—Spherical or oval cells, or granular cells with glossy, pale-yellow or yellowish-red pigmented contents, were most frequent; there was also present both finely and coarsely granular pigment, isolated or agglomerated, also in irregular (mostly black) flakes; once also, between the layers of the lamina spiralis ossea of the right petrous bone, a brownish-red, rhombic pigment-body (crystallized hæmatoidin). With the exception of the latter, the illustrations give the necessary additional information for the majority of the conditions.

Inflammation.

Microscopical evidence of an inflammation is probably furnished also by the sequelæ of the incomplete absorption of hemorrhagic infiltrations which were scattered through the membranous labyrinth. Its demonstration, however, was not possible in both labyrinths, but only in the left, and even here solely in the membranous semicircular canals and ampullæ; while in the right petrous bone—probably the one first attacked, perhaps as early as one year before death—degenerative processes had already been set up in nearly all regions of the labyrinth. Possibly the left labyrinth was the last to be affected with the hemorrhages—a matter regarding which the history of the case gives us no information.

Transverse sections of the membranous hollow formations of the left labyrinth (comp. Plates i and iii, Figs. 3 to 8) showed an infiltration with smaller and larger, partly

round, partly oval, single or aggregated nuclei or strongly granular cells. In various places, particularly in the connective tissue layer of the membranous ampulla of the left frontal semicircular canal, beside the nuclei and cells, numerous connective tissue corpuscles could likewise be demonstrated (see Figs. 4 and 8). In general, the described infiltration was most pronounced in the connective layer; in the other two, it was only exceptionably so great as to make the limit between the external and middle layers, or between this and the inner layer, indistinguishable (see Fig. 8, at the left of the drawing); and frequently then were found, with but sparse indications of an inflammation (see Figs. 4 and 5), products of the regressive metamorphosis. Newformed vessels were nowhere perceptible; altogether there was no organization of the exudation; the periosteum was only here and there thickened, and but rarely were the connective tissue trabeculæ—ligamenta labyrinthi—springing from it, hyperplastic. As to the evidence of inflammation on surface preparations, compare Plate ii, Fig. 14.

Much more pronounced were the evidences of atrophy and degeneration, especially in the labyrinth of the right petrous bone.

State of the Blood-vessels.

Conspicuous in all blood-vessels, without any difference as to their character, was the fact that they were filled to repletion with blood-corpuscles. A *partial* emptiness of the lumen (see Plate iii, Fig. 4) or even a *total* (see Plate i, Fig. 15) was among the rarest exceptions. Often the blood-corpuscles within the lumen showed a polygonal shape (see Plate ii, Fig. 1)—a proof of previous stagnation; or, where the vessels proved thickened, proof of a rather strong pressure exerted by the wall of the vessel upon the contents. The branches of the arteria auditiva interna, as well as the veins in the porus acusticus internus, not rarely had a sinuous or strongly twisted course. Ectasiæ belonged to the exceptions. On the other hand, the structure of the blood-vessels was altered. The arteries, in the left petrous bone, showed conditions of cellular infiltration; in the right, ra-

ther a thickening of the walls. Fig. 15, Plate i, shows a branch of the arteria auditiva interna sinistra with infiltrations of smaller and larger round uninuclear or multinuclear cells—conditions demonstrable likewise in many of the smaller arteries of the ampullæ and of the membranous formations of the vestibule. On the respective arteries in the right petrous bone, the cellular infiltration of the vessel wall was less pronounced (see Plate i, Fig. 16). The walls showed themselves already partially more or less thickened, oftener the structure was indistinct, the walls assumed in places a more glassy aspect—similar to the arteries of the dura mater of the same side (see Plate i, Fig. 17)—and accordingly were stained but faintly or not at all. The structure of the wall, in some vessels in the porus acusticus internus and in the canal of Rosenthal of both petrous bones, was also indistinct in consequence of fatty degeneration.

On smaller veins and transition vessels (see Plate iii, Fig. 4), I not infrequently found spindle-shaped thickenings of the walls. The following conditions, however, I must especially note: I found one spiral vessel of the left cochlea partially obliterated. The wall of the vessel, obviously composed of two membranes, was about double the breadth of the lumen, and so materially thickened that the latter was filled only by a *single row* of blood-corpuscles of polygonal form; for a short distance, immediately adjoining the row of blood-corpuscles, the lumen was only filled with a dirty white finely-granular mass;* thus followed the totally obliterated portion resembling a white band; further on, the lumen of the vessel with a *single row of polygonal* blood-corpuscles and the thickened wall was again visible. Neither vessel wall nor contents, the blood-corpuscles excepted, took a trace of the stain. Finally, I must not pass over the great scarcity of blood-vessels which I observed in the neighborhood of the the periosteum, in the connective

* In conditions like these, it is barely possible to decide whether we have to deal with a filling of the lumen by the fatty degeneration of the endothelial cells after preceding proliferation, or with a blood coagulum with succeeding fatty degeneration of the thrombus. The latter theory, however, appears more probable.

tissue layer of various preparations (see Plate iii, Fig. 5, and Plate i, Fig. 6).

Capillary Fat-embolism in both Petrous Bones.

Particular mention should be made of the *casual* conditions of *capillary fat-embolism* in the *labyrinth of both petrous bones.*

In the *right* (not treated with osmic acid) petrous bone, in the porus acusticus internus, some capillary vessels (in the region of the ramus n. cochleæ) were found in some portions filled to repletion with fat (see Plate ii, Fig. 23.)

In the *left* (treated with osmic acid) petrous bone, the fat-embolism was found in a part of the capillary network of the inner surface of the cochlear aqueduct, near its termination into the jugular vein.

In one capillary vessel which contained but few blood-corpuscles were found five smaller and larger, almost spherical globules of fat which had been dyed black by the osmic acid (see Plate iii, Fig. 20); further, in its neighborhood, a small section of a network of capillary vessels completely filled, as it were injected, with band-like ropy masses of fat, colored black by osmic acid; in but few places these black masses showed interruptions. (See Plate iii, Fig. 21).

In the same region, externally to the blood vessels, was found spread out alongside of them a large irregular patch of *extravasated fat*, dyed a sepia black by the osmic acid, composed partly of single, partly of conglomerated, often compacted, small and large, sometimes oval, sometimes circular fat-globules (see Plate iii, Fig. 22).

Finally I must state that I saw upon the surface of the left frontal membranous semicircular canal, likewise *externally* to the vessels, and scattered in different places a small number of black-colored fat-globules, exactly like those figured in Fig. 20, Plate iii, *within* a vessel. I emphasize this, because similar conditions in the right labyrinth, which had not been treated with omic ascid, might have escaped me, and the fat-embolism might have existed to a greater extent than it was manifest to me. In any case, there is no doubt that there was a fat-embolism in *both*

petrous bones, existing in various regions thereof; its *source* probably should be sought in the *terminal affection*, the *bed-sores*. Possibly the fat may have come from the medulla ossium of the patient, who had been reduced by marasmus. Obviously, in this case, exposed vessels* absorbed fatty substances from the suppurating subcutaneous layer of fat, and floated them along into the capillary region of the two petrous bones. I could not demonstrate any particular pathological effect of this manner of vascular occlusion. Special alterations were wanting in the surface preparation of the cochlear aqueduct. The occlusion of the capillaries was probably not extensive enough; possibly the process may have belonged to the last hours of the patient.

The condition ranks with the similar ones hitherto known—in the capillaries of the lungs, the smaller vessels of the heart, the liver and the kidneys, the brain, the conjunctiva, etc.

States of Atrophy and Degeneration in the Membranous Labyrinth.

From the preceding remarks upon inflammatory conditions in the labyrinth we saw that they were demonstrable only within limited regions, chiefly in the left petrous bone, viz., solely in the membranous hollow formations of the semicircular canals, of the ampullæ, and in the sacculi, but not in the internal auditory canal nor in the cochlea. In opposition hereto we find conditions of atrophy and degeneration in nearly the entire labyrinth. The membrana propria does not participate at all. Participating now in greater, then in lesser degree are: the *connective-tissue layer* and the *epithelial layer* of the membranous formations, as well as the *nerves*.

* Blood or lymph-vessels. Com. Max Wiener: "Wesen und Schicksal der Fettembolie. Habilitationsschrift," Leipsig, 1879. Wiener has experimentally demonstrated that fat is absorbed and transported, not only by blood-vessels but also by lymphatics. Excepting severe cases, in which a lethal issue is possible, fat-embolism, in the great majority, has no or only inconsiderable alterations in its train, resulting from its mechanical effect of the occlusion of vessels, never inflammatory processes. The excretion of the fat is regarded by Wiener as a simple process of filtration, not based on any alteration of the vessel-wall.

Atrophy and Degeneration of the Connective-Tissue Layer and its Cellular Elements.

The examination of *transverse sections* demonstrates:

The above-described cellular formations surrounding the ligamenta labyrinthi, also found between the meshes of their connective-tissue offshoots and in the perilymphatic spaces, perish by granular and fatty decay; the transmutation is performed mainly by granular cells, still encountered in the connective-tissue layer, along with the terminal products of tissue-degeneration, in greater or smaller numbers. The molecular disintegrated masses partly infiltrate the connective-tissue fibrillæ, partly they are deposited between them in the perilymphatic spaces which they fill more or less completely. In an obviously latter stage, even the fibrillæ of their ligamenta and their lesser offshoots assume a granular aspect; many of them only consist of rows of the finest granules, like a string of beads; finally they, too, disintegrate. By the molecular degeneration of the connective-tissue fibrillæ of the ligamenta labyrinthi the latter become narrower and the perilymphatic spaces larger; if finally the molecular masses of detritus get lost during the preparation of the specimen, those large lacunæ become visible in the tissues which are depicted in Plate iii, Fig. 5, and Plate i, Fig. 6, and in which nothing can be seen but large-meshed connective-tissue trabeculæ without any vessels; and as the latter are not demonstrable *even in the neighborhood of the periosteum* (comp. Fig. 6), it is not impossible that they participate in the degeneration and perish. I have, however, obtained no preparations which could have furnished me reliable data for this interpretation.

Besides the granular cells characteristic of the process described, we encounter *colloid* and so-called *hyaline* globules. Of these hereafter.

In surface *preparations* it may be shown that the fatty degeneration of the connective-tissue layers occurs now in smaller, then in larger patches; they are rarely distinctly circumscribed, mostly irregularly diffuse, and distinguish

themselves ordinarily by their darker quality compared with the parts which have not shared in the degeneration. Where the formation of granular cells was very ample, the coloration assumes a more yellowish cast. Where, in surface preparations, a portion of the products of degeneration has been lost, the respective places appear as bright islands. They thus naturally become much more transparent and thereby greatly facilitate the examination of more deeply situated layers. It barely requires mention that the degenerated portions can be stained but imperfectly or not at all.

Fatty Degeneration and Disappearance of the Epithelium.

The epithelial layer of the membranous semicircular canals and their papillæ, of the ampullæ, and of the membranous sacculi showed partly a normal, partly a pathological condition. Where the epithelium was preserved, it had throughout, in consequence of the strongly granular quality (often, perhaps, the effect of re-agents), a darker appearance. In many places, however, could be demonstrated conditions of fatty degeneration, of disintegration, and finally of complete disappearance of the epithelia, especially in the membranous semicircular canals. We may well consider the strongly granular quality of the cellular protoplasm in the vicinity of the nucleus, at times of the nucleus itself or of the entire cell-contents, as the incipient stages of the pathological process; later, the epithelia lose their contents partially or entirely, though their cement-ridges may be still preserved. Finally the epithelial wall loses its coherence; the contour of the cement-ridges is only indicated by fine granules; withal the epithelial cells may still inclose a nucleus, which is generally contracted, or they may be without nuclei; at last the cell-wall has perished altogether; only free, contracted nuclei are seen, or else, they too are absent; the epithelial cell with nucleus and contents is molecularly disintegrated and is entirely absent. In surface preparations, such portions are characterized, as already stated in regard to the external wall, as white, bright spots. Besides, there are noticeable in the visual field *numerous granular cells* and

smaller and larger fat-granules, occasionally also colloid globules (see Plate ii, Fig. 14). The staining of such preparations, in regard to the cell-contents, yields a negative result. The nuclei, too, stain but faintly or not at all as soon as they show any shrinkage.

The majority of the conditions just described are illustrated in Plate ii, Fig. 1.

Respecting the entire absence of the epithelium, both in surface preparations and intransverse sections (comp. the papillæ without epithelium in Fig. 3), it may, of course, be objected that the whole is artificial, and accordingly it should be decided whether the place in question *was* already during life *free from epithelium* by the entire disintegration and loss of the cellular formations, or whether it had *become free from epithelium* post mortem, by dropping off during the preparation. Opinions anyway are divided whether, in the normal condition, the papillæ possess an epithelium or not. Lucæ declares them to be free from epithelium. Rüdinger is of the opposite opinion, and I side with the latter. In surface preparations of semicircular canals which, as I described above, owing to the atrophy of the connective-tissue layer, greatly favored the examination of more deeply situated layers, and excluded artificial conditions, I could convince myself of the presence of epithelium on many papillæ; but on others it was entirely absent. Th absence, of course, was conditioned by the pathological process.

The Degeneration and Atrophy of the Nervous Elements.

(See Plates ii and iii, Figs. 9 to 12.)

It must appear surprising that, after treating both petrous bones for months with chromic and nitric acids,* and the left one, besides, with two per cent. osmic acid, the trunk of the auditory nerve still showed a *remarkable softness;* it was absolutely impossible to make transverse sections. This at the start led me to expect alterations. These in general were *characterized by an ample formation of granulated fat-cells, metamorphosis of the medulla into drops of myeline,*

* Repeatedly also with alcohol.

*crumbly masses, or fine granules of fat, even to complete disappearance of the medulla, atrophy and shrinkage of the single primitive nerve-fibres,** *disappearance* of the nuclei of the perineurium which, where it could be demonstrated at all, consisted of extremely attenuated, homogeneous bright fibres. Nerves thus altered were stained by iodine-violet only a pale-blue or not at all; those normally preserved, an intense blue. A total atrophy *of all nerves of the several regions could nowhere be demonstrated;* nearly throughout, normal nerves were found beside the atrophic; although I was enabled to follow the atrophy in general from the trunk in the porus acusticus internus on the one side as far as between the layers of the lamina spiralis ossea; on the other side, as far as nerve-terminations in the utriculus and in the crista of the ampullæ. At the trunk of the auditory nerve, the central parts were in the main still normal, while those more superficially situated were mostly altered. In some nerve-fibres, there showed itself, as the highest degree of atrophy, a bare, narrow, thin axis-cylinder of a grayish gelatinous appearance, such as has been described in the gray degeneration of the posterior fasciculi of the medulla oblongata, in which the formation of granular cells was less pronounced; in others there occurred a transformation of the medullary nerve-fibres into extremely delicate fibrillæ, with deposits of fat-globules and drops of myeline (see Plate iii, Fig. 12).

Stained preparations of such nerve portions showed, besides the absence of the medullary sheaths and a small number of atrophic axis-cylinders, mainly fibres of connective tissue with nuclei. There were also now and then visible smaller and larger globular, faintly glossy formations, sometimes homogeneous, sometimes cleft into separate sectors. As the latter were stained bluish, and not red, by iodine-violet (see above, the method of examination), I took them to be colloid globules. Nevertheless, Dr. Freidrich Schultze, who has ample experience in the pathological histology of the nervous system, thinks they should be designated as corpora amylacea.

* A comparative measurement of the normally preserved primitive nerve-fibres from the ramus vestibuli yielded 0.0063, while the atrophic fibres measured 0.0021, *i.e.*, only one-third.

I succeeded also in demonstrating an atrophy in the terminal nerve-cells in the crista of the ampullæ; it was characterized by a homogeneous or entirely hyaline quality of the *non-nucleated* cell-contents. The hyaline quality of these cell-contents struck me also in some of the external ciliary cells of the organ of Corti.

The *ganglion cells* took part in the alterations of the nerves hitherto described; this is true for the ganglion cells of the ramus vestibuli, as well as for those in the canal of Rosenthal; but here, too, the normal condition was the rule.

Many of them showed, instead of the granular contents and the vesicular nucleus, an evenly homogeneous quality without any nucleus, together with preservation of the form of the cell without axis-cylinder; others had already lost part of the homogeneous contents, were partially empty; others, again, showed an irregular form, and more or less pronounced shrinkage of the nucleus, which, instead of the vesicular, had a dumbbell-shaped or strongly notched appearance.

GRANULATED FAT-CELLS AND HYALINE GLOBULES.

Of the products of degeneration, both the granulated cells and the so-called hyaline globules require a short description.

Granulated Fat-Cells.

They showed themselves most frequently of all pathological formations, both in the connective tissue and on the epithelial layers, as well as in the nerves of the most varying zones.

Their *color* was more or less dark, now and then with a yellowish cast, with a peculiar lustre. Their *size*, too, varied greatly. In *form* they showed great diversity; often they were round, often oval, also club-shaped, at times slightly bent in the centre. Often they were scattered singly or in groups, at times strung together chainlike (along the nerve fibres).

Their *mode of origin* is certainly varying. In the connective tissue layer, they probably originate partly from the nuclei and their cells; partly they probably are, when they show a more yellowish, glossy color of their contents, products of the pigment-metamorphosis, in which the cells containing the blood corpuscles are the most important. In the epithelial layer, they probably stand in closer connection with the fatty degeneration of the respective cells; in the region of the nerves, with the resorption of the disintegrated medulla of the nerves (and ganglion cells?). The disintegrated medulla is taken up either by the lymph-corpuscles, or, where the nerves possess a sheath, by the nuclei of the latter.

Hyaline Globules. (See Plate ii, Fig. 1, and Plate iii, Figs. 4 and 5.)

In the epithelial layer of the membranous semicircular canals, in their connective tissue layer, and in the connective tissue layer of the ampullæ, I have met with numerous smaller and larger, sometimes globular, sometimes oval, glass-like, non-nucleated formations, with rather dark outlines, which I would designate as *hyaline globules.* More recently, von Recklinghausen* and his pupil, L. Wieger,† have anew drawn attention to hyaline and the hyaline degeneration. Wieger observed the hyaline degeneration in the lymphatic glands and the vessels, and, like his teacher, v. Recklinghausen, considers the whole process creating hyaline products as a subacute or chronic inflammatory one, producing a peculiar material, and in which the protoplasmic contents of certain cells are subjected to a substantial alteration, with increase of size, lustre, and refractive power of the cell-contents. Simultaneous with these vitreous, hyaline cells, there occurred also such as rendered themselves conspicuous by the *absence of a nucleus.* With the latter, the formations observed by us agree with the description and

* Tageblatt der 52-ten Versammlung deutscher Naturforscher und Aerzte in Baden, pp. 259 and 260.

† Ueber hyaline Entartungen in den Lymphdrüsen. Virchow's *Archiv*, Bd. lxxviii, H. 1, p. 25. Aus dem Strassburger pathologischen Institut.

the illustrations of Wieger. Perhaps, Wieger maintains, we here have to deal with the protoplasm of the nuclear cells deprived of its nucleus. This would lead to the assumption, perhaps, of a separation of cellular protoplasm and nucleus as the origin of the hyaline substance. Wieger distinguishes two hyaline substances: *lumpy* and *homogeneous*. The latter alone enters into our consideration. Regarding the reagents mentioned by Wieger it should be remarked that the homogeneous substance is stained light pink by carmine, and not at all by hæmatoxylin (which, according to Wieger, is anyway variable). The reaction with carmine yielded for our formations likewise a uniform, light pink coloration, but also a pale blue staining by hæmatoxylin. Mineral acids did not dissolve the respective formations.

Possibly the formations observed by me are also products of the demonstrated inflammation, in which the protoplasm of some cells in the connective tissue layer and the epithelial layer had undergone the peculiar metamorphosis supposed by Wieger.

Recovery of the alterations in the labyrinth.

On considering more closely the symptoms during life, the post-mortem appearances, and the described histological alterations in the labyrinth, the question as to the origin of the latter would not seem to be easy to answer; on the other hand, the assumption of a coöperation of different factors would appear to lie near.

One possibility we must deny above all, namely, the conjecture that the hemorrhagic infiltrations, or the presence of *pathological* pigment in the labyrinth, has any connection with the described alteration in the middle ear. True, in purulent inflammation in the middle ear, in consequence of the well-known vascular connection between the drum cavity and the labyrinth, which has recently been thoroughly investigated by Politzer, stasis-hemorrhages with pigment metamorphosis do occur, but not to an extent as in our case; besides, a purulent otitis media was found only

on *one*, the *right* side, the alterations in the labyrinth on both sides.

The capillary fat-embolism found in both petrous bones we also think of subordinate importance in regard to the recovery from the alterations in the labyrinth. In the first place, because they are not extensive enough, and hence of no moment respecting a disturbance of the circulation of blood; in the second place, because they owe their origin most probably to the *terminal affection*—the bed-sores,*

In the report of the autopsy we lack any data for assuming a *universal* disease of the arterial vascular system, in which the labyrinthine vessels participated. Nothing is mentioned but a *slight* atheromatous degeneration of the basal vessels.

On the other hand, in this respect, the *intracranial process* deserves particular attention—the *pachymeningitis hæmorrhagica.*

According to Kremiansky (l. c.), it begins, in most cases, in the region of the arteria meningea media, and may gradually spread to all the meningeal arteries; hence his distinction of pachymeningitis media, anterior, and posterior.

Rindfleisch (l. c., p. 578) sums up the modus of the process in the following: "The arteries, too, are dilated, more convoluted than normal, and surrounded by an *exceptionally* thick, felt-like adventitia. The hyperæmia of the capillaries expresses itself in a scarcely perceptible pink hue of the otherwise white and smooth inner surface of the dura, but during the entire process it remains stationary at this unimportant stage of development. The more remarkable, however, is the process developing at and upon the surface of the dura mater, on the basis of this hyperæmia. To the

* Should, however, the described fat-embolism be based upon a metastasis of the medulla ossium standing in closer connection with the marasmus, then it might have existed in the labyrinth a considerable time and might not have been without some influence upon many pathological conditions. For it is well known that Scriba (Untersuchungen über die Fettembolie, *Deutsche Zeitschrift für Chirurgie*, 1879, xii) has demonstrated that, on simply agitating blood with oil in a test-tube, a destruction of red blood-corpuscles (by mechanical or chemical influence?) with disarrangement of hæmoglobin takes place; Scriba has has also demonstrated free hæmoglobin in the blood-serum of animals into whose veins considerable amounts of oil had been injected.

naked eye, there is at first but a loose, veil-like, yellowish deposit interspersed with numberless hemorrhagic spots and points. On detaching the deposit, we may observe here and there some red threads which stretch from the dura mater to the pseudo-membrane, and break immediately after. These threads are nothing but vessels which extend from the dura mater into the pseudo-membrane, where they anastomose in star-shape."

In Virchow's opinion, this membrane is an efflorescence of the dura mater, and every *hemorrhage* is consequent on its peculiar structure The sub-epithelial layer of the dura is, according to Rindfleisch, the main source of the new-formation. From the opening vascular pores, according to Rindfleisch, first formative cells, then vessels issue; the former furnish the loose, connective-tissue parenchyma; the latter are the vessels of the new membrane. The newly developed capillary net acts like a safety-valve against the blood-pressure in the interior of the dura mater, increased by the active resistance of the fibrous tissue. According to Rindfleisch, the vascular structure of the pachymeningitic membrane moreover leads to rupture of vessels. The older the pseudo-membrane, the greater are the effusions of blood, up to those hemorrhages, the thickness, and breadth of the hand, which which were formerly termed hæmatoma of the dura mater. The cause of the hemorrhage is this, the older the pseudo-membrane, the more frequent is an obliteration of the vessels and rarefaction of the interstial tissue. The blood comes to a stasis in the trunks, as it is prevented from flowing into the ramification, and thus is caused the danger of hemorrhage.

Clear as this demonstration is regarding the recovery from the intracranial hemorrhage, it does not serve us for the recovery from the labyrinthine hemorrhage, provided that the morbid process, as proved by Kremiansky, follows the course of the meningeal artery and its branches, and further provided that it follows the latter *exclusively;* because, as is well-known, the organ of hearing is supplied by another plexus, namely the vertebral artery.* Yet the possibility

* Exceptions, however, seem to occur. Dr. Kuhn (verbal communication), of Strasburg, observed the origin of the arteria auditiva from the middle meningeal artery, but only unilaterally.

is not excluded, that this plexus likewise, although in the latter stage of the disease and perhaps less intensely, may be subjected to this pathological process; whether it be the trunk of the vertebral artery or its branches, which at any rate we could scarcely conceive without finer anastomoses with the capillaries from the plexus of the meningeal artery. Although I could not find any new-formed blood-vessels in the internal ear-canal, etc., it still remains very remarkable that I succeeded in demonstrating alterations of vessels in the plexus of the arteria auditiva interna, partly resembling those above described, namely, on the one hand an infiltration of the vessel-wall with smaller and larger round cells, on the other hand thickenings (although but slight) of vessel-walls, and exceptionally even occlusion.

But in this case the suspicion is hard to suppress that the alterations of the vessel-walls should not be considered as having any connection with the *primary* ones of the intracranial process, but as *secondary* ones, caused by the hemorrhagic infiltrations arising from the increased pressure through diapedesis. These then would have originated in a manner similar to the intravaginal hemorrhages of the optic nerve mentioned in the introduction, which were traced by Manz and Fürstner to the increased intracranial pressure. It is true, in this way the hemorrhages into the cochlea and the peri-lymphatic spaces of the labyrinth would not be explained, provided that the present assumptions as to the relations of pressure in the internal ear to similar conditions of the subdural and subarachnoidal spaces are modified. More detailed amplifications on this matter I have given already in my article on Combined Disturbances of Seeing and Hearing, in the ARCHIVES OF OPHTH. AND OTOL., Bd. vii, pp. 489 et seq.

If we finely take into consideration that every so-called paralytic attack was each time accompanied by impairment of the acuteness of hearing until it became totally destroyed, the theory, that every attack of meningeal hemorrhage was associated with a similar effusion into the labyrinth, has much to commend it.

The result, therefore, may be summed up in the following:

The auditory disturbances in hemorrhagic pachymeningitis are based on hemorrhages by diapedesis into the labyrinth which accompany the meningeal hemorrhages, and which, in repeated attacks, may lead to the total destruction of the function. The latter is caused by atrophic and degenerative processes in the labyrinth, in which both the trunk of the auditory nerve and its terminal expansion are pre-eminently involved, and in the occurrence of which the disturbances in the circulation of blood and in the nutrition of the tissues form an important factor.

Finally I desire to call attention to the fact that in the history of the case the absence of data in regard to symptoms of vertigo is excessively surprising if we consider that the histological examination has demonstrated a considerable affection of the membranous semicircular canals. However, I feel less inclined to discuss this theme in this place, as the case was one of a paralytic. In the cases above cited from Abercrombie and Andral, by the way, symptoms of vertigo are specially mentioned.

EXPLANATION OF THE PLATES.

Fig. 1 (Plate ii). A section from a surface preparation of the lower third of the right frontal (posterior) membranous semicircular canal, seen from within. Hartnack $\frac{8}{8}$. Tube closed.

Shows a dendritically branching vessel—belonging to the exterior wall—densely filled with blood-corpuscles. The latter have partly a polygonal form. Within one of its terminal branches (to the right above) some yellowish particles of pigment. The greatest amount of pigment is found externally to the blood-vessels, near their walls, as smaller or larger, variously shaped yellow pigment-corpuscles. Further, numerous epithelial cells, in great part already denucleated, show a diffuse pigmentation. Many granulated fat-cells of varying form and size may also be seen. Most of the epithelial cells are altered: one part still shows the natural form, but has no or else only shrunken nuclei; in others, only the cement-ridges, indicated by strings of granules of fat, remind us of the former shape of the epithelial cells: of others nothing but the naked, partially shrunken nucleus remains; and in one place, nearly in the middle of the generally downward

coursing vessel, the epithelial layer is entirely absent. This place is characterized as a *white spot* in the field of vision. The formations scattered about the greater part of the visual field, being smaller and larger, strongly marked by their light appearance from their surroundings, partly oval or pear-shaped, are probably of a hyaline nature.

Fig 2 (Plate i). A transverse section from the left frontal semicircular canal. Hartnack $\frac{3}{4}$. Tube closed.

The drawing is made in order to prove, from the aspect of the topographical distribution of the pigment, its topographical nature.

The transverse section forms an oval ring, the broader side of which is still connected with the periosteum and the bone; its exterior and interior surfaces appear somewhat uneven in places. On the exterior surface (right), the roughnesses are owing to the connective-tissue trabeculæ which are situated between the periosteum and the wall of the membranous canal; on the interior wall (left), to the so-called papillæ. In *all* layers, and also where the lamellæ of the periosteum diverge, there are smaller and larger patches of pigment.

The place between the two pillars is depicted again in the following figure, with Hartnack $\frac{8}{9}$.

Fig. 3 (Plate i). *K*, bone. *Pe*, periosteum. *B*, connective-tissue layer. *MP*, membrana propria. *E*, epithelial layer with the papillæ.

The epithelial layer and the membrana propria are in some places, and the connective-tissue layer to a great extent is, infiltrated with smaller and larger, partly round, partly oval, single or aggregated nuclei, also with sparse, strongly granular cells. The periosteum is somewhat thickened. Some of the connective-tissue trabeculæ starting from it show already (especially at the left of the drawing) a strongly granular condition. Right, near to the pigment, there is a large pear-shaped alveolar space, filled with fine detritus and surrounded by connective-tissue. Upon the papillæ, the epithelium is lacking. Some smaller and larger pigment corpuscles of varying forms are present in the connective-tissue layer and the membrana propria. In the epithelial layer may be seen a larger patch consisting of granular, rust-colored pigment.

At the base of the two adjoining papillæ is a patch composed of sparse nuclei and fine molecular masses of detritus.

FIG. 4 (Plate iii). A part of a transverse section through the roof of the membranous ampulla of the frontal left semicircular canal. Hartnack $\frac{8}{9}$. Tube closed. *a*, a band of attachment of the membranous ampulla to the periosteum, in its downward course, partly densely covered with oval cells, the nuclei of which are strongly granulated. (The other letters refer to the same structures as before.) The epithelial cells are strongly granular; the membrana propria 0.025 *cm.* broad, with distinct nuclei. In the meshes of the connective-tissue layer, above the blood-vessel (right, in the drawing), numerous cells of different size and shape, with granulated nuclei. A like condition obtains, only more strongly developed, between the vessel and the membrana propria. In the immediate neighborhood of the latter the majority of the cells are of spindle-shape. Throughout the field of vision there are smaller and larger hyaline globules. Some connective-tissue fibrillæ are already in the incipient stage of granular degeneration (below on the left in the drawing). In the centre of the field of vision there is a transverse-running capillary vessel, partly empty, partly filled with blood-corpuscles. The empty portion, left, shows fusiform swellings of the walls.

FIG. 5 (Plate iii). A portion of a transverse section through the bony and membranous roof of the ampulla of the right frontal semicircular canal. Hartnack $\frac{8}{9}$. Letters same as in Fig. 3.

The epithelial layer, owing to the strongly granular condition of the cell protoplasm, of a dark appearance. The membrana propria shows spindle-shaped nuclei. The connective-tissue layer shows the most considerable alterations. The connective-tissue fibrillæ of the bands of attachment of the ampulla, A, and their offshoots show partly finely-granular infiltration, partly they themselves are in the incipient stage of granular degeneration. The cells of the band of attachment (comp. Fig. 4) have perished and are entirely absent. Between two thus altered bands of attachment is a large perilymphatic space, still containing in places conglomerations of molecular masses of detritus. In the connective-tissue layer, there are, moreover, numerous smaller and larger, single or aggregated cells of varying form. Finally smaller and larger, round and oval, bright bodies, probably hyaline spheres. Right across the field of view run three capillary vessels filled with blood-corpuscles, the lower one partially covered by a cell-group.

Figs. 6, 7 and 8 (Plate i) had to be drawn *separately* for technical reasons. Together they represent but a *single preparation*,

namely, a transverse section through the bony and membranous ampulla belonging to the left frontal semicircular canal, and through the respective crista. *K*, bone; *P*, periosteum; *Ps*, planum seminulatum; *N*, nerves. Fig. 7, corresponds to the nerve-bearing zone of the crista; Fig. 6, to the portion to the right; Fig. 8, to that to the left of the nerve-bearing zone.

In Fig. 6 the following is noteworthy: The periosteum is thickened. In connection with this are a considerable number of connective tissue trabeculæ, which, joining in arcades, leave tunnel-shaped interstices between them. The connective-tissue trabeculæ are nothing but the so-called ligamenta labyrinthi; but they have lost their fibrillar structure and their investing cells. The tunnel-shaped interstices enclosed by them are perilymphatic spaces. Besides a few granulated cells, the latter contain to a great extent a fine, rather homogeneous appearing substance, probably masses of detritus which have been only partially preserved in the preparation. Besides, the perilymphatic space at the extreme left shows, together with a still partially preserved perilymphatic connective-tissue network, more granular contents which is also visible to some extent in the one at the extreme right. The described masses of detritus are probably products of disintegration of the cells of the ligaments, and of the contents of the perilymphatic spaces. The meshes of the connective tissue situated between the arcades and the cylinder epithelium cells are infiltrated with numerous round nuclei, with some granular cells, and with smaller and larger fat granules; the latter are probably products of the regressive metamorphosis of the cellular infiltration. There may also be seen, in the connective-tissue network just described, smaller and larger, round, yellowish-brown pigment corpuscles; at the left and the right of the drawing also some granular pigment of like color. The layer of cylinder epithelium is only sparsely infiltrated with round nuclei, but otherwise unchanged. Upon it a projecting mass of tasselated, unchanged epithelial cells from the wall of the ampulla has been left in making the transverse section.

Especially notable is the entire absence of blood-vessels in the neighborhood of the periosteum. (Disappearance of the blood-vessels as a result of the degenerative process? !)

FIG. 7. Nerve-bearing zone of the crista. The roundish cells (basal cells) of the nerve epithelium are absent; in the preparation of the specimen they were partly dislocated (right and left

above in the drawing, in the neighborhood of the terminal cells), partly they were lost; the most strongly projecting terminal fibre has been pulled out in making the section; its fusiform dilatation is not pathological, but the effect of the reagents employed.

Quite noteworthy is the infiltration of the nerves and of the connective-tissue with round nuclei; the infiltration extends as far as the membrana limitans. Besides, the meshes of the connective-tissue show a granular infiltration. Throughout there are but few small pigment corpuscles.

The nerves appear unchanged. Some terminal fibres end distinctly in a terminal cell.

FIG. 8. In the connective-tissue layer (left) we find a small number of round nuclei and cells, now and then a granular cell, further a large number of spindle cells. The region of the membrana propria is infiltrated with a large number of round nuclei; its structure, as well as the limit between it and the connective-tissue layer which is ordinarily distinctly visible in transverse sections, cannot be recognized in consequence of the alterations described. The epithelial layer succeeding the propria has been detached in the preparation of the specimen and is missing.

FIG. 9 (Plate ii). A portion of a transverse section through the crista of the ampulla of the left (posterior) frontal semicircular canal. Hartnack 3/8. Tube closed.

We see terminal nerve fibres, partly with their terminal cells, which have been cut in different directions, and therefore do not show a uniform shape. The basal cells are missing for the reason stated in Fig. 7. In a large part of the single nerve fibres we see, besides smaller and larger granules and drops, granular cells of mostly oval form. A like condition prevails between the nerve fibres, but here the shape of the granular cells is more roundish. A bell-shaped terminal nerve cell, and two more at its right, without nuclei. At its limit and above the membrana limitans in its immediate proximity, molecular detritus. Most of the nerve fibres on the proximal side of the membrana limitans have no longer a double outline. From the left end of the membrana limitans a bifurcating capillary vessel runs in a slanting direction to the right and below. Finally, three scattered yellow pigment corpuscles may be seen.

FIG. 10 (Plate iii). (*a*.) A small nerve trunk. (*b*,)A teazed preparation from the ramus nervi vestibuli dext. Hartnack 3/8. Tube closed.

We see numerous granular cells of varying size and form. Some nerve-fibres have lost their medulla entirely, are considerably narrowed, and show a more grayish appearance. (Gray degeneration ? !)

FIG. 11 (Plate ii). Teased preparation of a nerve from the canal of Rosenthal in the right petrous bone. Hartnack 3/8. Tube closed.

We see nerve-fibres in various stages of atrophy with granular cells.

FIG. 12 (Plate iii). A small nerve trunk from the ramus nervi cochleæ dextr.; from its superficial layers. An unstained glycerine preparation. Hartnack 8/8. Tube closed.

We see only extremely attenuated threads, with deposits of smaller and larger nuclei and granules, and of mostly roundish and oval bodies: drops of myeline. (As to results of staning reagents upon these objects comp. the text, p. 130.)

FIG. 13 (Plate ii). A section of a surface preparation from the sacculus in the neighborhood of the septum, seen from within. Hartnack 8/8. Tube closed.

We see smaller and larger, single and aggregate, partly strongly granulated cells of varying form and size. Some cell-groups are inclosed in a common investing membrane.

FIG. 14 (Plate ii). A section of a surface preparation from a different part of the sacculus. Inner surface. Hartnack 8/8. Tube closed.

We see round and oval nuclei and cells, granular cells, colloid globules, and some ochre-yellow pigment-corpuscles, all of varying size. The colloid bodies dark, and partly having a concentric arrangement. Reaction for corpora amylacea negative. Regressive metamorphosis of an inflammatory patch.

FIG. 15 (Plate i). A branch of the arteria auditiva interna from the left porous acusticus internus. Hartnack 8/8. Tube closed.

The wall of the vessel may be seen to be infiltrated with smaller and larger, uni- and multi-nuclear round cells.

FIG. 16 (Plate i). A branch of the arteria auditiva interna from the right porous acusticus internus, partly with thickened wall, partly with still cellular infiltration. Hartnack 8/8. Tube closed.

FIG. 17 (Plate i). The same from the dura mater at the surface of the right petrous bone, in proximity to the porous acusticus internus, under the same magnifying power.

FIG. 18 (Plate ii), *a*, *b*, *c*, *d* and *e*. Different stages of the pigment metamorphosis of (formerly) blood corpuscle-bearing, contractile cells, from the connective-tissue layer of the left frontal membranous semicircular canal. Hartnack $\frac{3}{8}$.

FIG. 19 (Plate ii) is taken from the connective-tissue layer of a transverse section of a membranous ampulla of the right petrous bone. Hartnack $\frac{3}{8}$. Tube closed.

We see a network of vessels densely filled with blood-corpuscles; between and partly immediately adjoining them, partly single, partly aggregated, roundish or oval, yellow-colored pigment bodies, containing smaller and larger black granules and grains; those in groups make the impression of blood corpuscle-bearing cells, but they are not enclosed in a separate cell-membrane. Their outline is formed rather by the coalescing margins of the single bodies entering into the group.

FIGS. 20, 21 and 22 (Plate iii) are surface preparations (seen from within), taken from the cochlear aqueduct of the left side, near its termination in the jugular vein. In fig. 20, Hartnack $\frac{3}{8}$, tube closed, we see, inside a vessel containing but few blood-corpuscles, five smaller and larger, almost circular, fat globules, stained black by osmic acid. Some of the blood-corpuscles still contained in the vessel have lost their natural (disk) shape and size. Externally to the vessel we see smaller and larger, mostly roundish cells.

FIG. 21. Hartnack $\frac{3}{8}$. Tube closed.

We see a double vascular network—one situated superficially, the other more deeply. The latter consists of anastomosing capillaries, filled with blood-corpuscles; the former of transmitting vessels and capillaries (here, too, there is partial anastomosis). Of both vascular networks a part is filled with very dark masses of fat, stained black by osmic acid, and of band-like coherence—as it were, injected with them. Only in very few places this black mass shows interruptions. In most places the cohesion of the masses of fat, and the filling of the lumen, are so perfect as to make the respective vessels appear changed into black strings. Especially at the right of the drawing, the dark mass is separated from the clearly distinguishable vessel-wall, similar to the appearance, at times, of imperfect artificial injections.

The conditions represented in figs. 20 and 21 are those of fat-embolism.

FIG. 22. Hartnack $\frac{3}{8}$. Tube closed.

We see a large, irregular patch of fat, spread out *beside* the blood-vessels, and stained a deep black by osmic acid; it is composed partly of single, partly of aggregated, variously compacted, small and large, now oval, now circular, black fat-globules. Fat exuded from the blood-vessels.

FIG. 23 (Plate ii). Hartnack $\frac{8}{8}$. Tube extended.

A small section of a capillary vessel occluded with fat, from the plexus of the arteria auditiva interna of the porus acusticus internus *dexter* (*not treated with osmic acid*). The capillary vessel from which the drawing was made, as well as several others from the same region, showed to a great extent the condition depicted in the figure.

FIG. 24 (Plate ii). A part of a surface section of a basilar membrane of the right cochlea. Hartnack $\frac{8}{8}$. Tube closed.

We see a bifurcating blood-vessel with distinct double wall. It is to a great extent filled with closely packed blood-corpuscles. Outside the vessel-wall is to be noted:

a. Below it a tube clinging, snake-like, to the external vessel-wall, of a yellow color, and containing most minute black granules. It shows in some places more or less irregular ampulla-like ectasiæ. Probably a perivascular lymph-sheath bearing pigment.

b. Above it, club-shaped and cactus-like adjoining formations, the narrower part of which is generally turned toward the external vessel-wall; their contents like those described under *a*. They are, probably, plasmatic channels or lymph-vessels. The two pigmented club-like formations, to the left at *l*, lie partly *upon* the vessel-wall; those in their shape somewhat resembling them, and the yellow pigmented roundish body at *m*, are *below* the vessel-wall; just as the pigment body at *a* lies immediately adjoining it.

FIG. 25 Plate ii). From a longitudinal section of the basilar membrane of the left cochlea, under the same magnifying power. The outlines of the section-plane of the respective basilar membrane are indicated by two lines. We see a formation similar to that described in Fig. 24, sub *b*. It was situated free upon the basilar membrane, *i.e.*, without any blood-vessels in its vicinity. Numerous formations, alike in their coloring and similar in their shape, could be demonstrated upon the same cut-surface.

A CASE OF PRIMARY EXTERNAL INFLAMMATION OF THE MASTOID.

By SWAN M. BURNETT, of Washington, D. C.

ACCORDING to Knapp, Turnbull and others, this form of mastoid inflammation, first described by Voltolini, seems to be uncommon, and for this reason I am induced to report the following case of that character which fell under my observation some years ago.

Mr. P. F., a carpenter, 28 years of age, after an exposure to cold, was seized with a pain back of the ear, accompanied with swelling. When I first saw him, the swelling was confined to the portion of the temporal bone at the rear, and slightly above the auricle.

It finally extended over the whole of the mastoid, and to the external meatus. There was no evidence of existing or previous disease of the auditory apparatus, and the *Mt*, on inspection, was found to be normal, and the hearing power good. It soon became evident that pus was forming, but all operative interference was refused, and treatment was limited to hot applications and anodynes.

In the course of ten or twelve days pus discharged from the external meatus, and it was discovered, when the swelling had sufficiently diminished to allow inspection, that it came from an opening just behind the cartilaginous portion of the external meatus from above. The pus had evidently burrowed backward along the cartilage, until it could find an exit through the less resistant integument. In the course of a week the discharge had ceased, and all manifestations of the trouble had disappeared. Up to the time of the discharge of pus, there was considerable febrile excitement.

ON HEREDITO-SYPHILITIC AFFECTIONS OF THE EAR.

By H. KNAPP.

AS the syphilitic affections of the ear have of late attracted so much attention, I beg to report a few cases in which the aural disease was the consequence of hereditary taint.

Cases of *primary ulcer* (chancre) of the ear have never come under my personal observation, though there is no doubt that they occasionally occur on the auricle as well as on the eyelids. A case of soft chancre is mentioned by A. Deprès, *An. des Mal. de l'Oreille et du Larynx.* December, 1878.

Manifestations of *secondary syphilis*, syphilides, ulcers, condylomata, etc., are, it seems, not so very rare as I thought them to be when describing, in the eighth volume of these ARCHIVES, p. 165, an exquisite case of condylomata, for, in addition to the bibliography which I mentioned in my communication, they are described, as my reviewer in the *Mon. f. Ohr.*, 1879, p. 152, says, in the works of Gruber and Schwartze on syphilis in the auditory canal. Furthermore, cases of syphilis of the external ear are reported by Dr. A. H. Buck in the *American Journal of Otology*, vol, i, p. 26, etc., two of which, Cases 4 and 5, were condylomata, and had escaped my attention

Observations of affections of the ear *propagated from the diseased naso-pharynx in syphilitic persons*, showing all varieties of inflammation of the middle ear, are well known and have frequently come to my personal notice.

I have also seen cases of *brain syphilis* in which neuritis optici and irido-cyclitis were accompanied by marked *impairment of hearing*, headache, dizziness, and staggering gait, without any abnormity in the naso-pharynx and sound-conducting apparatus.

Cases of parenchymatous keratitis with notched teeth and a plain history of hereditary syphilis have, in a large number, come under my care. A small fraction of these showed lesions of the middle and inner ears. The percentage would probably have been larger had my attention been more particularly directed to this complication. The same remark has been made by Jonathan Hutchinson in his classical work, "A Clinical Memoir on Certain Diseases of the Eye and Ear consequent on Inherited Syphilis," in which the affections of the eye are exhaustively described, but those of the ear receive an inadequate attention.

He mentions hardness of hearing in 15 cases out of 102 of syphilitic keratitis, and adds the history of six other cases in which he noted total or high degrees of deafness, without adequate changes in the external and middle ears, the examination of the ears being made by James Hinton.

Schwartze's excellent historical review of the literature on syphilitic affections of the ear (*Arch. f. Ohrenh.*, iv, p. 258, etc., 1869) shows that aural affections consequent on hereditary syphilis have been described by many authors, namely, by v. Tröltsch (*Text-book* and Virch. *Arch.*, xvii, p. 19, Case 5), A. Pagenstecher (*Deutsche Klinik.*, 1863, 41–43), Hutchinson (l. c.), J. Hinton (Clinical Remarks on Perforation and some other Morbid Conditions of the *Mt*, London; a supplement to *Toynbee's Text-book*, p. 461), Wreden (*Mon. f. Ohr.*, 1869, Nov., p. 169). Schwartze mentions from his own experience that the purulent otitis media of heredito-syphilitic infants is often rapidly cured. Hinton states that hereditary syphilis furnished more than one-twentieth of all the aural patients at Guy's Hospital, where he had charge of the out-door department for ear diseases. This statement, if true for Guy's Hospital, cannot be generalized, for 5 per cent. of all the ear patients would furnish in a dispensary which has 1,000 patients yearly, 50 cases

of heredito-syphilitic deafness, a number which is not borne out by any statistics. Hinton (Supplement, p. 461) further says: "Evidently it is the same disease, or one of the diseases, which Sir William Wilde * describes as affecting the ears in early life, subsequently, or alternating with, an inflammatory affection of the eyes." Of this there is no doubt, for the description of Wilde is quite clear. He says, "What is called strumous ophthalmia, and also corneitis, are the forms which the eye affection assumes. Occasionally it is that of choroido-iritis."

The connection between the affections of the eye and ear in this disease did not escape so fine an observer of nature as Wilde, though he failed to detect their common cause. Hinton, in his "Atlas of the Membrana Tympani," gives two pictures (Plate i, No. 3, and Plate ii, No. 2) of the appearance of the drumhead of heredito-syphilitic patients, but they offer no characteristic features. In the first "the membrane is of a hazy whiteness, not opaque; anteriorly and above a small white mass appears to be seen *through* the membrane; and below, its natural hue appears." In the second "the membrane was thin and somewhat opaque; a dense cretaceous mass posteriorly." In his "Questions of Aural Surgery," (1874), p. 290, he states that the diagnosis of heredito-syphilitic deafness is aided by the appreciation of the general symptoms and the ophthalmoscope. (?) "It generally comes on about or before the age of puberty, and mostly after the eyes have begun to recover. The deafness rapidly becomes very intense, and is evidently seated in the nerve apparatus, the tuning-fork not being heard. Among the poor, who are exposed to hardships and overwork, I have found the affection practically unrelievable, but among the wealthier classes it often appears less severe, and I have frequently found decided amendment to ensue. I have no settled plan of treatment." Dr. A. H. Buck (*Am. Journ. of Otol.*, i, p. 35) mentions in his report of 30 cases of syphilitic affections of the ear one case of complete deafness from doubtful hereditary syphilis.

These literary extracts will suffice to show that careful

* *Aural Surgery.* Amer. edition, p. 265.

observations and reports of new cases of heredito-syphilitic ear disease are still needed to clear up many doubtful points; in fact, it seems to me that the clinical material of this affection is still far too scant and fragmentary for a general description, and this is the reason which prompted me to communicate the following observations.

CASE I.—*Keratitis parenchymatosa, otitis media catarrhalis and otitis interna heredito-syphilitica. Recovery.*

Mr. S. G.'s daughter consulted me first Nov. 6, 1877, being at that time 5 years old. She had well marked parenchymatous keratitis of the right eye, of about two months' standing, and the beginning of the same difficulty in the left eye. She was a pale, feeble, but very vivacious child, with small, decaying teeth. At birth she was very small, and had an eruption all over her body, including the palms of her hands. The mother had had two miscarriages, and three of her children died in the first weeks, having also had coppery eruptions over their bodies. The father confesses to constitutional syphilis before his marriage, though he had had no symptoms from it after his apparent cure, and appears a strong and healthy man in every respect. The mother has a pale and sallow complexion. I treated the child for a long time with calomel in small doses, sublimate and iodide of potassium, at intervals with tonics. The corneæ grew very dull, and iritis with filiform synechiæ set in, as was seen when the corneæ had cleared up. The local treatment consisted of instillations of atropia, warm applications, and, later, yellow ointment, vinum opii, and insufflation of calomel powder. The corneæ gradually cleared up, but there were several relapses of keratitis.

In Februrary, 1879, that is, 18 months after the beginning of the eye disease, and when this was in a fair way of getting well, the hearing in both ears became rapidly and so much impaired that, in five days, the child could not understand the loudest speech, but always heard the sound of the voice. This condition lasted for a week, then improved somewhat. On account of a recent confinement of the mother, the child was brought to me only some weeks after the hardness of hearing had set in. She had had no pain in the ear, no noises, but headache. Her gait was unsteady and staggering. She was frequently dizzy, easily fell, and was always afraid that something would happen to her.

I found both drumheads sunken, the left reddish; the pharynx red and swollen. *h R* $\frac{113}{24}$, *L* $\frac{1}{\infty}$ (ear and bones of skull); *V R* $\frac{8}{60}$, *L* $\frac{3}{60}$. The tubes were pervious, but Politzer's experiment made the hearing worse. I sprayed her naso-pharynx, ordered a gargle, and prescribed 0.12 of iodide of potassium internally three times daily, and a Turkish bath twice a week. Later I gave her calomel, 0.02 pro die. During the first two months the hearing was at times better, at times worse, than when she first came. At the beginning of the third month she had a relapse of keratitis, and the headache, dizziness and disturbances of equilibrium were very marked. The left drumhead, however, looked fairly normal, the reflex bright and triangular, *R Mt* pinkish. A great deal of phlegm in the naso-pharyngeal cavity. *V* $\frac{8}{60}$, improved by Politzer's method to $\frac{20}{60}$ on either side. From that time a more or less steady improvement took place. At the end of May the pharynx and drumheads had become normal, the triangular reflexes being bright and regular in shape. Yet *V* was only $\frac{20}{60}$ in the right, and $\frac{10}{60}$ in the left ear. At the end of June the hearing power for the voice had become normal in either ear. She passed the summer on the sea shore at Long Branch, where, in August, she had a relapse of keratitis, but not of otitis.

The last examination I made February 5, 1880, a year after the onset of the ear difficulty. There was again moderately pro-pronounced catarrhal pharyngitis. The right *Mt* was semi-transparent; its anterior lower parts were sunken: the tendinous ring was well marked, the reflex divided, bright only at its point. *Mt* movable by Sigle's otoscope; on suction the reflex became regular; the same after Politzer's method. The left *Mt* was perfectly normal, its reflex triangular and bright. *h* = $\frac{20}{24}$; *V* (whisper), $\frac{20}{20}$ on both sides.

This case, in my opinion, shows as clear and complete a picture of heredito-syphilitic otitis as has ever been described. According to the clinical history there could be no doubt about its etiology.

The occurrence of the affection of both ears in the course of parynchymatous kerato-iritis agrees with the statements of authors.

The *time of its onset*, was before the usual period, which is about the fourteenth year. This period, however, varies very considerably, also for parenchymatous keratitis.

The almost *sudden* appearance of a high degree of *impairment of hearing* has long been noticed as peculiar to syphilitic deafness.

The symptoms in our case plainly denote that *both the middle and internal ears participated* in the affection. In the middle ear a catarrhal inflammation was unmistakable on account of the marked physical changes. These were, however, not so extensive as to account for the high degree of deafness. An implication of the labyrinth had to be assumed, even if the positive symptoms of it had been absent. These symptoms, well known under the name of Ménière's disease, were headache, nausea, vomiting, dizziness, staggering gait, tendency to fall. One symptom only, tinnitus aurium, was not complained of.

The *labyrinth affection was of longer duration than the catarrh of the middle ear*, for at a time when both the naso-pharynx, the tubes and the *Mtt* presented normal conditions, the labyrinthine symptoms were still marked, and the hearing power was reduced to $\frac{1}{60}$. In uncomplicated acute inflammations of the middle ear, the hearing function is restored long before the normal condition of the parts is found on physical examination. The features and the course of the case also demonstrate that the morbid process in the labyrinth was not only the more important, but also the more intense of the two affections.

The duration of the disease was shorter and its course less fluctuating between better and worse than is common.

The most important feature, however, which distinguishes this case from the majority of others is its *complete* and, as it seems, *permanent recovery*, with preservation of perfect hearing.*

CASE 2.—*Keratitis parenchymatosa, otitis media catarrhalis and otitis interna heredito-syphilitica. Recovery from inflammation, but deafness left.*

Mrs. G. S., æt. 23, consulted me in May, 1878. When she was five years old, her mother died of consumption, her father of

* Patient seen May 22d, 1880. Had had no relapse. Ears and hearing normal.

dropsy in the same year, having had "some private disease." She had three brothers and sisters who were sickly, and died soon after they were born; the one had no hair, the other was a cripple. She was healthy until she was seventeen years old, when first one, then the other eye was affected. The eye disease lasted two years, and from the description and the diffuse haziness of both corneæ, most intense in the centre, the diagnosis of parenchymatous keratitis may be made without hesitation. During the course of her eye disease she had, every now and then, attacks of headache, tinnitus aurium, nausea, dizziness, unsteady reeling gait, as if she were intoxicated. Sometimes she had to take hold of a lamp-post in the street, lest she fall down. Her hearing was at once impaired, and became gradually worse in the course of eight months, during which she was subject to the above attacks. Later she had spells of sickness and vomiting. When she consulted me I found her complexion sallow and pale, the teeth notched, the corneæ hazy, as described above, the pharyngeal mucous membrane somewhat red and swollen. *h* R $\frac{1}{\infty}$; L o; V R $\frac{10}{60}$; L $\frac{1}{60}$. *Mtt* sunken, dull; tubes pervious. I ordered calomel 0.005 three times daily. Her attendance was very irregular.

I saw her again, February 6, 1880, in the following condition: General health improved; *h* R $\frac{1}{\infty}$, L o; no bone conduction on either side; Politzer's acoumeter, R ½″, L not at all, from bone everywhere, better on right than on left side; tuning-fork heard before the right ear only, not from bones of the skull, from the teeth well in right, scarcely in left ear; V R $\frac{5}{60}$, L $\frac{113}{60}$; flexible tube, R a whisper, L strong voice; audiphone, V $\frac{6}{60}$, with dipper-shaped trumpet $\frac{15}{0}$; with Politzer's method of inflation a full snapping sound heard through auscultation tube; hearing not improved; both drumheads very obliquely set; handles straight downward; reflexes small; color of *Mtt* milky near periphery, normal in centre: mobility of *Mtt*, by Sigle's instrument, perfect; pharynx fairly normal. This condition found the same, one, two, and three months later, entirely uninfluenced by mercury and iodide of potassium.

This case is, in its nature, quite similar to the previous. The impairment of hearing, however, seems to have been less sudden. During the last two years the hearing was reduced from V R $\frac{10}{60}$ to $\frac{5}{60}$, with almost total deafness on

the left side. The symptoms showed mild otitis media catarrhalis, but a marked labyrinthine affection. The patient was poor, and lived in very unfavorable hygienic conditions. Comparing the unfortunate course of this case with the happy result in the previous one, a child of wealthy parents, we find the above-cited statement of Hinton, as regards the influence of the external conditions of life on the prognosis, most strikingly exemplified. This comparison, at the same time, is suggestive of the proper method of treatment in such cases. We should, therefore, not frame too unfavorable a prognosis, but treat heredito-syphilitic deafness with circumspection and perseverence. In parenchymatous keratitis from hereditary syphilis, we frequently obtain quite satisfactory results, owing, possibly, to the fact that eye patients, in general, are better cared for, expose themselves less, and seek and receive more competent and persistent medical attendance than ear patients.

I have seen more cases of ear disease in heredito-syphilitic persons. Their number, compared with that of parenchymatous keratitis, was small. The form of disease was mostly characterized by the preponderance of the labyrinthine symptoms over those of the catarrhal inflammation of the middle ear. In one case I saw, combined with a most intense keratitis, extensive ulceration of the velum palati, a perforating ulcer of the hard palate, and purulent otitis, with destruction of the drumheads, and partial absence of the ossicles in both ears. The ear disease, however, was not a purely syphilitic affection, for the patient, a girl of 15 years, had had otorrhœa in early childhood from scarlet fever.

The two above-described cases are the most characteristic I have observed. They may fairly be regarded as typical examples of the disease under consideration.

A CASE OF RUPTURE OF THE DRUMHEAD FROM A BOX ON THE EAR. RAPID AND COMPLETE RECOVERY.

By Dr. THOS. J. DILLS, of Fort Wayne, Ind.

MARCH 30, 1880, Dr. Carl Proegler, physician-in-charge of the Concordia College in this city, kindly brought to my notice the following case:

Theodore Lueders, æt. 16, a native of Missouri, whose individual and family history was good. Two hours previously, during an altercation with a fellow student, he received a violent and unexpected box or blow on the left ear, from the effects of which he reeled, staggered, and momentarily lost consciousness. Regaining sensibility and consciousness, he complained of severe pain deep in the left ear, loud, roaring noises, partial deafness, unsteadiness of gait, slight nausea and faintness.

St. pr.—Patient obliged to sit down during the examination. The face was palid, and wore an expression of pain, anxiety and fear. My watch, which was heard by the right ear at 8′ (the normal distance, was heard by the left at 18″.

Otoscopic examination of *R* was negative. In the left, the *Mt* presents a clean, straight incision or fissure, 6 *mm.* in length, the centre of the wound 2 *mm.* below the insertion of the handle of the malleus, the direction being in the horizontal plane.

Upon directing the patient to perform the Valsalvian experiment, a small drop of bloody serum oozed out of the centre of the wound. The opposed surfaces adjusted themselves perfectly, and nothing was visible save the dark, thread-like fissure.

The tonsils were hypertrophied, and presented deep, ragged excavations, the posterior pharyngeal wall was studded with enlarged

follicles, and over all a dense coating of muco-pus. In answer to my inquiry, he denied ever having had any aural disease, or even the slightest impairment of hearing. He admitted having had measles three months ago, at which time he had a severe sore throat.

I advised seclusion and quiet. Three days after I saw him in his room in the hospital, at which time the subjective symptoms had in the main disappeared. *h L*=$\frac{4}{5}$. The fissure in *Mt* perfectly healed.

May 12th, again seen. All subjective symptoms have disappeared. Patient thinks he hears as well in the *L* as in the *R* ear. *h L*=$\frac{7}{8}'$; *h R*=$\frac{8}{8}'$. *L Mt* markedly retracted. At the site of the former fissure was dense cicatricial tissue, radiating irregularly above and below. By the catheter and Politzer's method the Eust. tubes were found patent and free from secretion. By careful examination of the *Mt* I observed that which was overlooked in my first and hasty exploration, viz., evidences of increased concavity of the whole membrane, foreshortening of the manubrium and increased prominence of the short process. No abnormity of color was manifest.

THE INDICATION FOR AN EARLY TREPANATION OF THE MASTOID PROCESS IN ACUTE PURULENT OTITIS MEDIA WITH IMPLICATION OF THE MASTOID CELLS.

By F. C. HOTZ, M.D., Chicago.

The prejudice once prevailing against the operation of trephining the mastoid bone has been pretty thoroughly eradicated. Once denounced as a surgical venture, it is now admitted to the honors of a legitimate operation; once invested with imaginary difficulties and dangers, it is proven by clinical experience a comparatively simple and very safe operation. In 1873 Dr. A. H. Buck* could record thirty-one operations with twenty-three good results, and "in the remaining eight fatal cases, death could not be attributed to the operation, directly or indirectly, in more than one case." And last year Prof. Schwartze completed a series of articles† "on the artificial perforation of the mastoid process," which reflect his experience in fifty operations. Of these fifty cases ten died; but the only certain death from the operation was one where, from a malformation of the mastoid, the middle fossa of the skull was opened, and the dura mater perforated by a splinter of bone, producing fatal meningitis.

"Past experience, Prof. Schwartze concludes,‡ shows that the dangers from the operation itself are pyæmia, exposing the mid-

* Diseases of the mastoid in Arch. Ophthalm. and Otol., III, p. 211.

† Arch. f. Ohrenheilkunde, Bd. x, xi, xii, xiii, xiv.

‡ See Amer. Journ. of Otology, vol. 1, p. 115.

dle fossa of the skull or the lateral sinus. Experience also shows that these two latter accidents may occur without injurious effect, if the dura mater and sinus are uninjured, and they may, unexpectedly, occur to any surgeon from a malformation of the mastoid bone, which is, however, very rare."

And since the danger from pyæmia has been so materially lessened by the antiseptic treatment, we see the danger from trephining the mastoid process reduced to a minimum!

Let us, on the other hand, see what the probable results of mastoid disease are without surgical interference. Dr. Buck* has found that of sixty-nine cases, "three terminated in a spontaneous recovery, twenty-two were operated upon and recovered, eight were operated upon and died, and the remainder, thirty-six in all, terminated fatally." In other words the chances of recovery without operation are (3 : 69) worse than the probability of death by the operation (1 : 35 Buckly or 1 : 50 Schwartze).

I have dwelt, at some length, upon the statistics because they are the most eloquent argument in favor of early opening an abcess of the mastoid process; they are an earnest appeal to every surgeon to be aware of the great danger to life which an abcess in the immediate vicinity of the brain must necessarily carry with it, and they strongly remind us that the only sure protection againt the destructive effect of pent-up matter lies in the early opening of the abcess. To those who regard the purulent inflammation of the mastoid process in the same light as an acute abcess in any other bone, these remarks reiterate only the well-established principle that an acute abcess should be opened at the earliest possible moment. But, as yet, many aural surgeons seem to deviate from this rule when dealing with an acute abcess of the mastoid bone. The reports in medical journals and the pages of the text-books on diseases of the ear reveal a certain reluctance on the part of the aurists to resort to the operation. The operation is spoken of and resorted to as the *ultimum refugium* rather

*l. c., p. 216.

than as the surest and quickest cure of an acute collection of pus in the mastoid bone.

Let me substantiate and illustrate this remark by a few references to recent publications.

CHARLES H. BURNETT :* "If, after the above-named treatment, local depletions and the incision of the periosteum over the mastoid, the pain which may have been further combated by anodynes, should still persist, grow worse and be accompanied by symptoms of general constitutional derangement, the outer mastoid wall should be perforated."

A. H. BUCK :† "If these measures (*i.e.*, leeches and warm fomentations) do not give relief, and the unfavorable symptoms persist, a free incision through the integument and periosteum of the mastoid process should be made. *Should this latter procedure also fail, the bone should be trephined* or perforated in such a way as to expose the mastoid cells."

Prof. SCHWARTZE :‡ "As the first indication for the operation are to be mentioned, the acute inflammation of the mastoid process, with retention of pus in its cells, *where Wilde's incision* or the treatment with ice, *does not relieve the œdema*, pain, and fever."

Dr. H. KNAPP § in a recent article on "primary acute purulent inflammation of the middle ear :" "Of this operation I am not a great admirer, and perform it *only when the cerebral symptoms are threatening*."

H. GERVAIS :‖ "In case of continuous pain, swelling and redness of the mastoid process, Wilde's incision is recommended ; *if no improvement ensues within* 24–48 *hours the mastoid process is to be opened*."

These abstracts show a remarkable unanimity of opinions. The advice of all these writers is first to try local depletion by leeches, then to try it again by a deep incision, *and not until all other measures have failed, to trephine the mastoid bone*. By this practice from one day to one week of precious time is wasted ; one whole week more is added to the

* The Ear : its Anatomy, Physiology and Diseases, 1877, p. 541.

† ARCH. OPHTHALMOL. AND OTOL., Vol. viii, p. 211.

‡ *Arch. f. Ohrenhlke*, Bd. xiv, p. 205. The italics in this, as in all subsequent quotations are mine.—H.

§ ARCH. OTOLOGY, Vol. viii, p. 24.

‖ "Des abscés mastoidiens," noticed in ARCH. OTOL, Vol. viii, p. 414.

tortures of the patient, one whole week longer is allowed to the suppurative process to inflict irreparable damage upon the structure of the tympanum and its osseous shell. And what is gained by the delay? Nothing! For in all cases of suppurative inflammation of the mastoid cells treated according to the advice of the above references, Wilde's incision gave only temporary relief and either had to be followed by trephining, or was followed by a so-called spontaneous perforation of the bone provided no worse accident closed the drama before. Here are a few instances.

Dr. J. O. GREEN * reported, last year, two cases of acute purulent otitis media implicating the mastoid cells, to illustrate the importance of an early operation. In both cases œdema and tenderness of the mastoid appeared in the course of a purulent otitis of a few weeks' duration; in both cases the immediate operation of opening the mastoid cell was proposed, but refused. Two weeks later in the first case, and one week later in the second case, the operation was consented to and performed, when the bone was found carious and perforated by a fistula.

In a case of Dr. T. R. POOLEY'S,† Wilde's incision was made for the usual symptoms of mastoid complications. The bone was found healthy and no perforation was made. The patient obtained temporary relief. In the course of some days, however, the violent symptoms returned, and it was finally decided to trephine the bone, when it was discovered that nature had been before the surgeon.

Other highly instructive cases bearing upon the question of early or late trepanation in acute mastoid abscess, were recently published by Dr. J. W. Wanghop,‡ and Dr. E. Gruening.§ In all these cases Wilde's incision gave only temporary relief; the perforation of the mastoid bone was followed by evacuation of pus, complete relief and rapid recovery. Gruening's first case is of particular interest and may be briefly recapitulated.

* *Boston Med. and Surg. Journal*, Nov. 27, 1879.

† *Arch. of Med.* ARCH. OF OTOLOGY, Vol. ix, p. 103.

‡ *Am. Journ. Med. Sc.*, April, 1879.

§ ARCH. OF OTOL., Vol. viii, No. 1.

The purulent otitis lasted four weeks, when the patient came under Dr. G's care. He found discharge of fetid pus from the meatus; a small perforation of the drumhead; œdema, pain and tenderness of the mastoid region. Five leeches relieved the pain for 24 hours; then it returned with increased intensity, while the discharge became scanty. Wilde's incision was performed; the bone was found perfectly healthy, and the patient experienced great relief. "During the night the pain recurred with great violence; the patient became delirious, had several rigors, vomited repeatedly and responded sluggishly to loud questions." Now the bone was trephined, a considerable quantity of pus was removed, and the patient recovered.

Nobody, I presume, will deny that this patient was in a very critical state after Wilde's incision, and until trepanation of the bone was performed; and these alarming symptoms would undoubtedly have been obviated by an earlier opening of the mastoid cells. The delay of 24 hours was almost fatal to the patient, and submitted him to an unnecessarily prolonged torture. And there is one other objection to this practice, as illustrated by the above case. It necessitates the performance of two successive operations. Not every patient is intelligent enough to appreciate the wise precaution which prompts his medical attendant to perform the operation in two acts on two successive days instead of completing it at one sitting. In his agony of pain he cheerfully submits to an operation if he has implicit confidence in his physician, and if the operation promises him the longed-for relief from his suffering. The incision is performed, and for the first time in several weeks the patient enjoys a quiet sleep. But the relief is ephemeral; the pain returns with increased violence, and a second operation is proposed. But disappointed by the first operation, the patient may be slow or unwilling to consent to another one; he may despair of ever getting well, or mistrust the skill of his physician and conclude to try a change of medical attendance. It seems strange that so many surgeons still adhere to, and are warm advocates of, a mode of treatment so objectionable and irrational, where experience has established two facts: (1). That trepanation of the mas-

toid bone is attended with scarcely any greater danger than Wilde's incision; and (2), that this incision alone gives no permanent relief in cases of internal mastoid inflammation. Where it has had a permanent good effect upon the swelling, pain and tenderness of the mastoid region, these symptoms were caused by external periostitis. There is no valid reason to postpone the opening of the mastoid cells, when, as Dr. Roosa says,* "we have good reason to believe that there is pus in the middle ear or mastoid cells which cannot find an exit by the external auditory canal."

But here we find ourselves at once face to face with one great difficulty. "What are good reasons to believe there is pus in the mastoid cells?" Œdema, pain and tenderness, are symptoms of periostitis as well as of osteo-myelitis; they are associated with both inflammations, without and within the mastoid bone. Pain and tenderness are treacherous subjective symptoms, so that their degree, character, or extent cannot be relied on for differential diagnosis. A swelling of the mastoid region of rather firm consistence, and extending beyond the mastoid, without fluctuation, would strongly indicate intra-osseous inflammation. But we know how deceptive this symptom is; how often the most skilled experts have decided upon the presence or absence of fluctuation where afterwards just the opposite condition was found from that which had been anticipated. The nature of the swelling, therefore, does not give any positive evidence for or against pus in the mastoid cells.

One symptom, to which some writers seem to attach great significance, is, the sudden diminution or cessation of the otorrhœa. But it has repeatedly been observed that the mastoid cells became involved in the suppurative inflammation of the tympanic cavity without the slightest decrease of the discharge. And, on the other hand, we may bear in mind that there are other and graver complications (phlebitis and meningitis) which always make the most profuse discharge very scanty or stop it entirely.

It is evident, therefore, that of all the symptoms usually observed about the mastoid region none is suggestive

* A practical treatise on the diseases of the ear, 1873, p. 424,

enough to render a definite diagnosis possible. By combining and weighing all symptoms and circumstances we may decide for periostitis in one case, for mastoid abcess in another; but in either our diagnosis is made with a mental reservation. This uncertainty in the diagnosis, of course, must influence our treatment, and I believe it was this uncertainty which suggested the practice of cutting down into the periosteum and of deciding by the effect of this periosteal incision whether or not to trephine. I characterized this practice as objectionable, because it causes a dangerous delay of the final step of the operation, and I insisted upon an immediate opening of the bone whenever necessary. I showed, however, that the usual symptoms of mastoid inflammation are of no value for deciding this question. All they can suggest is the propriety of making an incision down to the bone. I would call it an *exploratory* incision, because it is necessary in order to explore and ascertain the true nature of the complication. This incision exposes the periosteum to our view; we can examine with our eyes the state of this membrane, and I should think it ought not to be difficult to determine whether or not there is any periosteal inflammation.* For in acute periostitis the fibrous membrane is commonly of a reddish, pink, or lilac hue; its vessels are loaded with blood and its substance is sensibly softened as well as slightly thickened. *Its attachment to the bone is also considerably diminished so that it may readily be peeled off.* Those changes in the periosteum are easily recognizable, and where our exploratory incision discloses such symptoms, we know there is a marked degree of acute periostitis; and as this periostitis may account for the swelling, redness and pain of the mastoid region we are justified to expect relief from the simple incision. Under these conditions we shall not proceed in the operation, but await the effect of the incision. But when by this incision we find a firm and thin periosteum which adheres to the bone so strongly that considerable force is required to tear it off; where we find no sign of periostitis, we must necessarily assume that the cause for the redness

* See S. D. Gross, System of Surgery, vol. i., p. 845.

and swelling of the soft tissues lies deeper than the periosteum; we are forced to the conclusion that they are due to inflammation within the bone, and we cannot logically expect any lasting benefit from the periosteal incision alone. Under these circumstances the incision is only the first step of the operation, and we shall not hesitate to make the second step directly after the first, *i.e.*, we shall proceed to complete the whole operation by trephining the bone.

It is evident that the examination of the periosteum plays a very important rôle in the proper management of these acute affections of the mastoid. Yet it seems as though aural surgeons have paid no attention to it. At least in all the reports I could examine I did not find a single instance where the state of the periosteum was mentioned, while the condition of the surface of the bone was always recorded. But in this early stage of periostitis we shall look in vain for any perceptible alteration of the osseous structure. Nor will the surface of the bone show any material disturbance in the early period of mastoid abscess. Only later on, the nutrition of the bone itself suffers in periostitis by the detachment of the periosteum, and in abscess by carious decay. But in the early stage of the disease under consideration I regard the state of the periosteum as the chief point of interest which shall govern our action in these cases upon the following principle: *When in the course of an acute purulent otitis media the mastoid region becomes implicated by pain, redness, swelling and tenderness to the touch, and these symptoms are not speedily relieved by leeches and poultices, an exploratory incision should be made down to the bone. If marked symptoms of acute periostitis are found, our surgical interference shall end with the incision. But if the periosteum is found of firm texture, normal thickness and strongly adherent to the bone, the incision should immediately be followed by the perforation of the bone.*

The advantages of this early and immediate operation are:

1. It abridges the suffering of the patient.

2. It saves the patient from the disappointment of an unsuccessful operation and from the anxiety and excitement of a repeated operation.

3. It shortens the course of the suppurative inflammation, and thereby limits its destructive effect.

4. It arrests the disease before it can become dangerous to life.

5. It enhances the possibility of restoring a useful amount of hearing power.

These advantages are fully verified by the records of the few cases in which the operation was early performed. They are plainly demonstrated by an observation reported by Dr. Knapp at the last meeting of the Am. Otol. Society.* By the early trepanation of the mastoid "pus was liberated, the patient's headache relieved at once, and the membrana tympani restored in two weeks; the opening in the mastoid closed in four weeks, and the hearing was normal again in six."

They are no less clearly set forth by the following two cases which were under my care in 1878:

Acute suppurative inflammation of the middle ear and mastoid cells. Trepanation of the mastoid. Rapid Recovery.

On the second of October, 1878, Pr. H., æt. 35, a very robust Bohemian, consulted me in reference to a painful affection of his left ear. He had never been sick and had never had any trouble with his ears. Two weeks previously he became thoroughly drenched by rain. This exposure was followed by violent pain in the left ear and left side of the head. The pain was especially severe at night, so much so that he had to take large doses of morphine to obtain rest and sleep. Four days after the attack the ear began to discharge, but the pain persisted nevertheless. I found the integument of the external ear red and swollen; also the skin over the mastoid reddened and a little tumefied, but not particularly tender. The external meatus was filled with creamy pus. The membrana tympani was deep red and showed at the lower border of the posterior portion of Shrapnell's membrane a slit-like opening from which the pus was oozing out quite pro-

* *Trans. of the Am. Otol. Soc.*, 1879, p. 350.

fusely. The patient's face bore the expression of great agony; his pulse was 112, tongue coated. I ordered three leeches upon the mastoid, instillations of a solution of atropine; and quinine with Dover's powder (āā 0.05) every hour.

October 6th.—The leeches relieved the pain almost instantaneously. Patient looked better, his head was free. The integument of the mastoid was less swollen, but the discharge was still very copious.

October 11th.—Yesterday the pain in the ear and side of the head returned with increased violence. Discharge very profuse; the skin of the mastoid red, swollen and very tender on pressure; especially near the posterior border of the mastoid process there is an exceedingly sensitive spot. Leeches were tried once more, and quinine and morphine internally.

October 13th.—No relief; and as the swelling and tenderness over the mastoid increased, I advised an immediate incision to be followed, if necessary, by the opening of the mastoid, as the quickest means of relief.

October 14th.—During the night the patient was wild with pain and consumed 1¼ pints of brandy till eight o'clock in the morning. He is slightly intoxicated and within two minutes fully anæsthetized with thirty drops of chloroform. The purulent discharge from external meatus is as profuse as ever; the tumefaction behind the ear extends upward beyond the upper end of the auricle; downward into the tissues of the neck, and backward almost to the median line of the occiput. A longitudinal incision, two inches in length, was made behind and parallel with the auricle, the knife was carried right down to the bone and the periosteum divided together with the soft tissues, in the whole extent of the wound. The tissues were 1½ inches thick and jelly-like but bled very little. Bleeding from a few cutaneous arteries was easily arrested by pressure. No pus was found under the periosteum which was firm and adherent to the bone, and the surface of the bone was smooth and hard. After pushing the periosteum backward Dr. Buck's conical drill was inserted in a line with the external meatus, and the bone perforated in a direction inward and slightly forward. The farther the drill advanced the softer became the bone; and when it had penetrated about ⅛ inch pus oozed out between the instrument and the bone. The drill was withdrawn and the opening enlarged with a gouge. A considerable quantity of creamy pus escaped. The cavity was probed,

but no caries could be detected. After injecting carbolized water the wound was dressed with carbolized chapie.

October 15th.—Patient passed a very good night; had no pain at all. Swelling behind ear considerably less.

October 16th.—Free discharge of pus from mastoid opening, none from the external meatus.

October 23d.—Patient called at office; wound filled with healthy granulations; no discharge from mastoid bone nor from external auditory canal.

November 9th.—For five days the wound has been entirely closed; there is a firm depressed scar adherent to the mastoid bone, meatus clean, membrana tympani shows its natural lustre and light spot; in its posterior half near the border of Shrapnell's membrane a linear scar. Hearing=$\frac{15}{24}$.

CASE 2.—*Chronic otorrhœa; acute relapse of inflammation after measles, complicated by mastoid abscess after a fall; trepanation and rapid recovery.*

D. D., æt. 8 years, was examined July 2, 1878. His mother gave this history. He had more or less discharge from both ears since his first year, but has not complained of earache, until last week. Three weeks ago he had measles and ever since that time, the ears had been quite sensitive to injections of warm water; the discharge became more copious, and last week the ears were quite painful.

Status præsens. L. Ear, Watch at $\frac{1}{2}''$, external auditory canal very wide and filled with muco-purulent secretion; dullness and opacity of drumhead with a large perforation in its postero-superior quarter. Mucous membrane of tympanic cavity very red and swollen, and bleeding on the slightest touch. Injections of warm water cause great pain. R. Ear, Watch $\frac{1}{2}$ inch, same discharge as in L. Ear; whole lower half of drumhead destroyed; mucous membrane very red and bleeding; still more sensitive to injection than L. Ear. By the use of an alkaline lotion and rest the sensitiveness of the ears and the congestion of their mucous membranes disappeared in one week. But on July 10th, the boy fell from a wagon bruising severely the right side of his face and head. Two days later the right half of his head began to ache, and a swelling appeared behind his right ear.

July 15th.—There is considerable swelling, redness and tenderness over the right mastoid, extending over the whole occipital region; violent pain in right half of head; moderate discharge

from left ear, none at all from right ear; three leeches behind ear, followed by poultices; quinine gr. ii, with pul. doveri gr. 1, every two hours.

July 16th.—Pain abated after leeching, so that the boy slept pretty well. But swelling and tenderness of the mastoid had increased and extended upward to the temporal region.

July 17th.—As there was no improvement, Wilde's incision was made under chloroform. Periosteum was found strong, thin and firmly adherent to the bone, the surface of which was smooth and hard. With Buck's drill the hard shell was perforated, the perforation enlarged and the inner softer portion removed with a sharp scoop. At least a teaspoonful of creamy pus was let out; no caries or necrosis was found. The wound was dressed antiseptically and the mastoid cavity cleansed every day by injections of carbolized water.

From that day on, the patient had no more pain in his ear and head, and improved so fast that on the fourth day he could go out again; all swelling had disappeared. The wound was filled with healthy granulations, and from the meatus there was a moderate discharge of muco-purulent matter. In three weeks the wound behind the ear was closed; but a slight otorrhœa persisted for some time.

Although in this second case chronic suppurative inflammation of the middle ear preceded the formation of the mastoid abscess, it exhibited all the characteristic symptoms of an acute abscess. It appeared in the course of an acute exacerbation of the purulent otitis media, was ushered in by marked symptoms of acute inflammation, and the bone showed no trace of caries or necrosis. Like in the first case, the perforation of the mastoid was undertaken for the purpose of liberating pus; and my principal reason for believing there was pus in the mastoid cells, was the absence of characteristic signs of acute periostitis. In both cases the result of the operation confirmed the diagnosis and demonstrated the advantages of an early interference.

REPORT ON THE PROGRESS OF OTOLOGY,

IN THE SECOND HALF OF THE YEAR 1879.

I.—NORMAL AND PATHOLOGICAL ANATOMY.

By Dr. H. STEINBRÜGGE, of Heidelberg.

Translated by Richard C. Brandeis, M.D., New York.

1. Dr. Joseph Pollak. Contribution to the pathological histology of the cartilage of the ear. *Monatschr. f. Ohrenheilk.*, No. 7, 1879.

2. Gardiner Brown, F.R.C.S., Aural Surgeon to the London Hospital. Asyntrophy of the right temporal bone. *Lancet*, November 8, 1879.

3. Prof. August Rauber, M.D., Leipzig. The lymphatics of the ossicula auditus. *Arch. f. Ohrenheilk.*, vol. xv., No. 2.

4. Dr. Weber-Liel, Berlin. Experimental proofs of a connection between the endolymphatic and perilymphatic spaces of the auditory labyrinth of man with the extra-labyrinthine intracranial spaces. Virchow's *Archiv*, vol. lxxvii, No. 2.

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1. Pollak found in the aural cartilages of subjects not affected with any mental disease, especially in the antihelix, small nodules, varying in size from a mustard seed to a lentil, in which some cavernous structure was recognizable. Microscopic examinations revealed similar conditions to those discovered by Pareidt, L. Meyer, Fürstner, and others: a hyaline degeneration, fibrillar disintegration, partial disappearance of the cartilaginous cells, while, in parts, groups of new cells had formed; lastly, open cavities with fluid contents were developed. The author is unable to explain the development of the open spaces, which are partly filled with bands of connective tissue.

2. Gardiner Brown describes a case of malformation of the right ear, with an abnormal position of the lower maxilla, occurring in a girl aged three years, who is otherwise quite healthy. In place of the auricle, which was absent, there was near the tragus a narrow flap, 1¼″ in length, the auditory passage was closed by soft parts, but the opening could be felt through them. The right cheek was flattened, the symphysis of the lower jaw, drawn an ⅛″ toward the right side, formed an angle of 11° with the median plane, in consequence of which the lower incisors of the left side were separated from those above. The ungeometrical development of the lower jaw is attributed by Brown to the malformation of the right temporal bone and the abnormal position of the fossa glenoidea.

3. Prof. Rauber, in alluding to the presence of lymphatics in osseous tissue, refers to his work "On the Elasticity and Density of Bone" (Leipzig, 1875), and thus asserts his priority to Schwalbe and Budge. He has recently found the same arrangement of lymphatics in the auditory ossicles as in the larger bones. The former were decalcined in a ¼ per cent. solution of chromic acid, and the sections made with the microtome were first stained with pilocarpin and then with hæmatoxylin. Special care must be taken that the bones do not become dry before they are decalcined. The result of the investigations was as follows: The blood-vessels contained in a Haversian canal do not quite fill its calibre, the space extending from there to the periphery of the canal containing from the lymph tube. The outer coating of the vessels, as well as the bony wall, are lined with endothelial cells, which thus represent the endothelial lining of the perivascular lymphatic space. The offshoots of the bone-cells also sometimes terminate in the lymph-tube. The peculiar position of the blood-vessels within the lymph canals, as well as the fixity of the bony walls of the canal, produces a mutual dependence of the elastic relations in both varieties. Congestion of the blood-vessels will repress the lymph spaces, and *vice versa*. The endothelia of bone, after having previously been subjected to a silver bath, were also found to be elongated polygons, and Rauber also found irregular polygonal cells in the subperiosteal and perimyelar spaces as well. Injections into the adjacent lymphatics, as well as into the subperiosteal lymph spaces, passed not only into the perivascular cavities, but into the bony canaliculi and cavities also.

4. Dr. Weber-Liel first describes the process of establishing

the intradural, endolymphatic sac, which constitutes the intracranial end of the aqueductus vestibuli. This can be produced by injecting air into the sagittal semicircular canal, or by forcing a colored fluid into it. The dilated sac has the shape of a flattened canteen, is from 12–18 *mm.* long, 5–9 *mm.* broad, composed of connective tissue, may be detached from the dura mater, and is lined on its inner surface with a layer of polygonal pavement epithelium, for which reason it may be classed as a serous cavity. Weber-Liel proves that it is in direct communication with the endolymphatic spaces of the labyrinth by his method of aspiration (see vol. vii, pag. 383 of the *Archives*). The author was not able to satisfy himself of the division of the aqueductus vestibuli into two halves, one of them extending toward the utricle and the other toward the sacculus. Moreover, the sacculi and the membranous canals, after having been colored by aspiration, were imbedded in a concentrated mucilaginous solution, and, after being hardened, were divided into minute sections, which were examined microscopically. The blue colored molecules were only found on the inner surface, and within the cochlea the ductus cochlearis only was stained.

The fact, that a light pressure upon the intradural sac will cause fluid to pass from the opened upper semicircular canal and, on the other hand, that this fluid can again be withdrawn with ease by suction applied through a rubber tube which is attached to the closed sac, brings Weber-Liel to the conclusion that there must be a free and easy communication of the sac with the labyrinth; this also points to the inference that there must be a mutual inter-dependence of pressure in these organs. Accordingly, the endolymphatic fluid may either be aspired or expelled simply by the respiratory movements of the brain, and during increased labyrinthine pressure the fluid may be forced into the cavity of the brain.

The communication of the perilymphatic spaces with the cavity of the brain, by means of the aqueductus cochleæ, was demonstrated, partly by means of injections through the subarachnoidal space, and partly by means of the method of aspiration. This latter can also be done through the external ear, if a glass tube is securely inserted into the same and the air within it rarified, while marked variations in pressure facilitate the egress of fluid through the aperatura aqueductûs cochleæ. Weber-Liel attributed these last two phenomena to bulging or retraction of the mem-

brane of the round window, corresponding to the movements of the membrana tympani. According to him, the secondary membrana tympani also transmits the sound waves to the cochlea. The deductions made are again referable to the mutual interdependence of the intracranial pressure and that of the perilymphatic spaces of the labyrinth.

II.—THE PHYSIOLOGY OF THE EAR.

By OSCAR WOLF, M.D., in Frankfort.

(With woodcut.)

1. Dr. Louis Blau, Berlin. A contribution to the doctrine of the functions of the chorda tympani. *Berlin Klin. Wochenschrift*, No. 43.

2. Prof. Hagen, M.D., Leipzig. The condition of the mucous membrane of the tympanic cavity after division of the trigeminal nerve in the cranial cavity. *Archiv. f. Experimen. Pathol. and Pharmacol.* 1879.

3. Laurence Turnbull, M.D., Philadelphia. The limit of perception of musical tones by the human ear. *The Boston Medical and Surgical Journal*, May, 1879.

4. Professor Alfred M. Mayer, Hoboken. Experimental researches on the determination of the forms of acoustic wave surfaces leading to the invention of the topophone; an instrument to determine the direction of sound. *The American Journal of Otology*, October, 1879.

5. Dr. Clarence J. Blake, in Boston. The logographic value of consonant sounds in their relation to their transmission by the telephone. *The American Journal of Otology*, July, 1879.

6. Dr. C. Preusse, Berlin. The application of the telephone for the determination of unilateral deafness. *Trans. of the Berlin Physiol. Soc.*, March 16, 1879. *Arch. für Anat. and Physiologie. Physiol. Section*, No. 3 and 4, 1879.

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1. Blau's case concerned a boy, aged 12 years, in whom a carious affection of the posterior superior wall of the auditory meatus had caused a small defect of the membrana tympani in

the region of a Troeltsch's sinus, and thereby exposed the chorda tympani. Irritation of this portion of the nerve, either by injections into the ear or by touching it with a probe, gave rise to two different sensations on the lateral border of the tongue, namely, perceptions of taste and sensation (trembling of the tongue). They sometimes manifested themselves simultaneously, and at other times only one or the other phenomenon made its appearance; the base and the tip of the tongue were not similarly affected. No effect on the secretion of saliva was discernible. The frequency with which perception of taste and sensation made its appearance, separately, was about the same; this was in the guise of a sour and sometimes bitter taste, and trembling and prickling in the tongue. Aside from this, the sense of taste was unimpaired on both sides when the chorda tympani was left in peace. Dr Blau. inquires, finally, whether the nerve would act similarly in case a paralytic influence was exercised upon it. His reviewer begs to call attention to a paper on this subject which will shortly appear in these ARCHIVES.

2. Professor HAGEN quotes Gellé, of Paris, who observed the case of a boy in whom there was a purulent discharge from the tympanic cavity after division of the trigeminal nerve, and then drew the deduction that the changes found were solely due to the esion of the trophic fibres in the fifth nerve. This was considered an argument in favor of Meissner's theory and a refutation of Snellen and Senftleben's doctrine of the mode of production of keratitis after division of the trigeminal nerve. Professor Hagen therefore determined, in order to settle this point, to examine the tympanic cavities of a number of animals in whom the nerve was divided without invading the cranial cavity. The animals survived the operation for a length of time varying from one hour to 9 days. In every one of them that survived more than 24 hours, keratitis set in. Only in two of the 13 cases did Hagen find any exudation in the tympanic cavities; in the remaining eleven there was no trace whatever. As both the dogs in which an exudation was found, were in a very bad condition—in one of them an exudation was also found in the tympanic cavity of the other side, which was not interfered with—the mucous membrane at the same time being pale and normal in appearance, Hagen considers the condition as merely accidental, and draws the inference "that the absence of all lesions of the tympanic cavities after division of the trigeminal nerve, found in the remaining

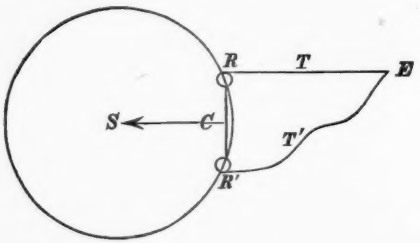
eleven cases, tends to strengthen the doctrine of the traumatic nature of Trigeminal keratitis."

3. Dr. L. TURNBULL, wishing to determine the range of perception of the human ear for high musical tones, employed a series of Kœnig's steel rods in his experiments. Special care was taken that the variations of temperature of the rods should be reduced to a minimum. Although Blake found that the perceptivity of the ear varies at different times of life, and that it is greatest from the 10th to the 12th year, gradually diminishing as years advance, Helmholtz fixing the maximum limit at 38,000 single vibrations, and Vierordt giving 40,000, Turnbull arrived at a greater average. A musician, aged 26 years, and another young man with an educated ear, were able to perceive tones having as much as 60,000 vibrations per second. Turnbull remarks accordingly, that perhaps the ear of some individuals is similarly affected as some eyes, notably as those affected with color-blindness. He also alluded to the cases already described by Dr. Earle, in which the same person was color-blind as well as unable to distinguish musical tones. But aside from such exceptions, Turnbull's experiments prove that practicing the perception of high tones will increase the range of hearing. Some persons who were subjected to a course of training, and were at first not able to distinguish tones with more than 30,000 vibrations, after the exercises were finished were able to perceive such with 35,000 vibrations to the second.

The temperature of the steel rods was about 70°, and they were struck by a steel hammer at about a distance of two inches from the ear. The tabular statement appended to the paper shows that the majority of persons experimented on were able to perceive from 40,000 to 50,000 vibrations to the second, a few from 50,000 to 55,000 (aged 22, 23 and 24 years), and one over 60,000 (aged 26 years). It may also be of interest to mention the fact that in the majority of cases the left ear was the best.

4. Professor MAYERS' paper gives us the details of an apparatus he has constructed which will, hereafter, enable us to determine with mathematical exactness, the direction from which a sound comes which has reached the ear. This report is not only of interest as bearing upon the theory of sound, but it also promises to be conducive to international intercourse, especially to the sea-faring profession. For good and sufficient reason, Prof. Mayer postpones a detailed description of the appa-

ratus to some future time, and devotes his paper to prove theoratically how, with the assistance of the well-known laws of the deviation and reflection of sound as well as the theory of interference, it is is possible to determine the source of sound by ascertaining the alteration of the form of sound waves.



Let S be a source of sound and the circle represent a wave surface produced by the sound S. On this surface all air molecules have at the same moment the same direction and move with the same rapidity. If now we are able to determine two points, R and R′ on the surface, and unite them by a straight line, then a perpendicular line passing at equal distance between them (C) will strike S. To determine the two points R and R′ two resonators are required which produce tones similar to the source of sound, and are connected by two tubes T and T′ with the ear of the observer. According to the law of coincidence, we find that if these two tubes are of equal length the observing ear will perceive an increased resonance; according to the law of interference there will be a diminution of the sound emanating from S as soon as the tube T′ is one-half of a wave-length longer than the tube T.

If the resonator attached to T′ is rotated around S, while the other remains fixed, there must be several positions in which the sound which reaches the ear ceases entirely; these are points on the surface of the sound-waves. Prof. Mayer also states that the experiments which he made in Central Park have proven that with the assistance of his apparatus, sound emanating at a distance of from 100 to 1,000 feet could be determined with an error of no more than 1–1½ degree. He has, also, at a distance of forty-five miles on sea, succeeded in determining the sound of a siren fog-horn within a deviation of 10°.

5. Blake, after having utilized the human membrana tympani for his logographic researches (some of which have been reported in vol. vii. of these ARCHIVES) has experimented with Bell's telephone in order to determine why some consonants are transmitted by this instrument better than others. To do this he connected a hand telephone with one of Thompson's galvanometers and then uttered consonants singly into it. The result was that T,—P,—B,—D, and K— caused the greatest, while M—and N— caused the least deviation of the magnetic needle, *i.e.*, the former group possessed the greatest and the latter the least logographic value, a fact which Blake endeavors to explain as follows:

In enunciating the so-called explosive sounds, the air which is exhaled acts with a decided force upon the diaphragm of the telephone, and depresses its centre considerably towards the magnet which is underneath, while, on the other hand, in phonating M and N, a portion of the air escapes through the nostrils. The result is, that there is an increased deviation of the magnetic needle in uttering the explosives, and a diminution in uttering the nasal sounds. As the dampening influence of the magnetic attraction on the vibrations of the telephonic disk is in an inverse quatratic ratio to the distance between the plate and the magnetic pole, the result is that the consonants which possess the highest logographic value are reproduced least distinctly by the ear-piece of the telephone. This also explains why B is often mistaken for M, and D for N, in using the telephone. The curves registered by the telephone were similar to those given by the human membrana tympani (as already published in these ARCHIVES). The reviewer hopes that Dr. Blake will extend his admirable investigation to S, Sch and G molle, as well as to B lingual, which consonants represent the extreme of the musical scale and have given the reviewer such marked sound-images.

6. Dr. C. PREUSSE has exhibited to the Physiological Society of Berlin an apparatus for the determination of one-sided deafness. It is well known that healthy ears always hear those sounds transmitted by electricity on that side to which the receiving telephone is attached. If, however, two telephones are attached to a galvanic circuit, and they are both held to the two ears, then the auditory sensation is formed on the occiput. This fact may be utilized in the detection of simulated deafness of one ear. The author thinks also that this fact may assist in establishing a deafness which has not previously been observed; but the reviewer is

of the opinion that we are already in possession of simpler means to attain this end (Politzer's acoumeter, the voice, the watch, the tuning-fork, etc.). Preusse's apparatus is composed of the following parts:

1. A Noe's star pile.
2. Hughes' microphone.
3. The receiving telephones for the person under examination.
4. A receiving telephone for the examiner, in order to determine whether the apparatus is in order.
5. Five of Pohl's commutators, which are attached to the circuit and enable us to determine the different experimental combinations.
6. One of du Bois-Reymond's keys for interrupting the current.

The author was of the opinion that the fact of a one-sided simulated deafness is determined as soon as there is a perception of sound which is located in the occiput, or while only the telephone in contact with the affected ear is acting, and, moreover, "tones are not so serviceable in the examination as noises are."

III.—EMBRYOLOGY AND COMPARATIVE ANATOMY OF THE EAR.

By LUDWIG LÖWE, of Berne.

1. Salensky. On the development of the small-bones of the ear. *Zool. Anzeiger*, 1879, No. 28.
2. Krauss. An organ similar to the oto-cyst, in the Tabanus Autumnalis Linnè. *Zool. Anzeiger*, 1879, No. 27.
3. Albrecht. The morphological significance of the lateral maxillary fissure, and the probable existence of four intermediate maxillæ in mammals. *Zool. Anzeiger*, 1879, No. 26.
4. D. Hunt. Some recent opinions concerning the development of the external ear passages. *Am. Journal of Otology*, vol. i, No. 4, pp. 250–258.
5. Elliot Coues. The outer ear of the Blarina Brevicauda. *Am. Journ. of Otol.*, vol. i, No. 3, pp. 161–162.
6. A. v. Brunn. Further investigations of the olfactory epithelium and its relation to the olfactory nerve. *Arch. für micr. Anat.*, vol. xvii, 1, pp. 140–150, with one plate.

(1.) SALENSKY. The cartilages begin to form in the first and second visceral arch in a sheep's embryo 2¼ *cm.* in length. They appear in the form of cylindrical rods inside the visceral arches, the first appearing above, the second below he first visceral fissure. The first cartilaginous arch is somewhat bent thickened at its point of curvature and slightly rounded at its pointed end.

The second arch exhibits the same conditions, only its curve is directed downward, instead of upward. There is no union between the posterior ends of the two visceral arches. In an embryo 2¾ *cm.* long, the foundations of both hammer and anvil are already indicated, by an indentation at the lower side of the thickened part of the first visceral arch, which is evidently determined by the different degrees of growth of the arch in the various portions, and forms the boundary between the hammer and anvil. The anterior edge of the indentation is drawn out into the shape of a small process, which represents the foundation of the manubrium mallei. In embryos 3½ *cm.* long, the separation of the two parts of the first visceral arch, *i.e.*, of Meckel's cartilage with the hammer and anvil, is already completed. The hammer appears as a thickened termination of Meckel's cartilage drawn downward. The anvil represents a triangular cartilaginous plate with its ends prolonged, the upper end leaning against the wall of the auditory capsule, while the lower end turns downward and unites with the foundation of the stirrup. The further devleopment consists in the growth of all the foundations here indicated; those of the manubrium growing most in the earlier stage, turning a cylindrical and somewhat pointed process forward and running parallel to and beneath Meckel's cartilage. In embryos 8 *cm.* long, we see the first traces of ossification in the two bones of the middle ear.

We must resort to cross-sections to study the development of the stirrup. If we examine such sections in an embryo 1½ *cm.* long, while there is still no trace of cartilage in the visceral arches and in the auditory capsule, we notice the facial nerve and external carotid artery external to the membranous labyrinth. These two organs indicate the spot where the foundation of the stirrup appears at a later date. The carotid, moreover, plays an important rôle in the development of this small bone. The facial at first runs somewhat downward, and then bends forward, where it passes into the inferior maxillary process. The external carotid, which lies somewhat behind the facial, sends off a branch which

passes forward toward the superior maxillary process of the first visceral arch.

Before the first foundations of the stirrup appear, the cartilaginous auditory capsule is already formed, with two distinct divisions; the posterior, which encloses the utricle with the semicircular canals, and may be called the utricular portion; and the anterior, which Salensky calls the cochlear portion because it embraces the cochlea. These two divisions are separated from each other by a furrow, in which lies the facial and external carotid. The outer wall of this furrow projects somewhat outwards, and forms an arch-like elevation, to which the anvil fastens itself by means of its outer process. The cross-sections shown in Fig. 461 of Kölliker's work, (*Entwickelungsgesch. der Menschen*, 2te Aufl.), illustrate pretty well the relative positions here described.

The development of the stirrup can be first seen in sheep's embryos 2½ *cm.* long. Cross-sections show it as an irregular ring-like mass of cells, which are pretty distinct in colored preparations, and through the middle of which the above-mentioned branch of the internal carotid runs. In comparison with the inner portion of the ring lying close to the facial, the outer portion is somewhat thickened; at a later period this difference in thickness disappears, and the cartilaginous development of the stirrup appears in the form of a plate perforated in the middle, and united with the inferior process of the anvil.

In somewhat older embryos, the original form of the stirrup is altered. The posterior part adjoining the auditory capsule smooths itself off, and becomes the plate of the stirrup; the neck is formed from the opposite portion, and the arms from the remainder. In embryos 8 *cm.* long, the stirrup already assumes a triangular shape, and shows itself in its definite form by a proportionately small hole.

It seems that the vessel, which, from the very first passes through the stirrup, is obliterated during the development of the embryo, for Salensky, at least, could see nothing of it in moderately developed (8 *cm.*) embryos.

The relations of the internal carotid, in the formation of the stirrup, may serve to explain facts described by some of the older anatomists; Meckel, amongst others, had already, in 1821, described the course of the internal carotid between the arms of the stirrup in the marmot and hedgehog; and Hyrtl likewise mentions the anomalous course of a vessel through the orifice of the stirrup.

Finally, as regards the question of the relation of the development of the bones of hearing to the cartilaginous visceral arches, Salensky accepts Reichert's view as correct concerning the hammer and anvil. The development of the stirrup, however, is quite different from that described by Reichert, since the stirrup has no relations to the second visceral arch. It developes itself independently of the other bones of hearing, as a cartilage of the embryonal connective tissue, in the neighborhood of the internal carotid. As this connective tissue represents a portion of the original first visceral arch, the stirrup must be regarded as an independent centre of cartilage-formation, in the region of the first visceral arch.

2. In 1875, Prof. BRAUER demonstrated the larvæ, drawn from the eggs of the tabanus autumnalis, (Linnæus,) and drew especial attention to a hitherto unknown and noteworthy organ in the lower part of the body. Krauss' drawings of this organ agree so well with those which Graber made of it, that there can be no doubt of the identity of both larvæ, and that Graber's fly-maggot provided with oto-cysts (*Arch. für Micr. Anat.*, Band xvi, p. 47), is to be considered as the larvæ of the tabanus autumn., (Linnæus, Vieh-Bremse). Krauss says that there can be no doubt of the organ in question, even in the fully developed fly, and that there we might find a clue to many enigmatical appearances about them.

3. ALBRECHT concludes that lateral maxillary fissures (hare-lip) in mankind, never appears between the upper and intermediate maxillæ, but is always intra-incisive. He examined the skulls of children in the anatomical collection at Königsberg and Kiel, and found that in 70 per cent. of all the cases, five incisive sutures or their remains were demonstrable on the hard palate. These five sutures define the boundaries between the medial and lateral portions of the intermediate maxillæ and the two superior maxillæ on the palatal side of the maxillary apparatus. He calls the medial segment of the intermediate maxilla, on either side, the endo-gnathion ; the lateral segment, the meso-gnathion, and the superior maxilla the exo-gnathion. The first of the five inter-maxillary sutures lies between the adjoining endo-gnathion (sutura inter-endognathica), The following suture existing on both sides between the endo- and meso-gnathion is the sutura endo-mesognathica. Then comes, on both sides, the sutura meso-exognathica, between the meso- and exo-gnathion,

which hitherto was described κατ' ἐξοχήν as sutura-incisiva. Finally, we have the sutura inter-exognathica existing between the processus palatini of the superior maxillæ on both sides. According to former views, the lateral maxillary fissure only coincided with the sutura meso-exognathica, while in all the cases that Albrecht saw, it coincided with the endo-mesognathica.

If now, this extraordinarily frequent appearance of a suture between the medial and lateral intermediate maxillary segments indicates the probable original foundation of two intermediate maxillæ on each side, four in all, the assumption becomes all the more probable inasmuch, as Albrecht has found the suture lying between the medial and lateral segments of the intermediate maxilla, *i. e.*, the sutura endo-mesognathica, also in other mammals viz. up to this time in pinnipedia and apes. The five intermaxillary sutures are so distinctly defined upon the facial surface of the maxilla of an ape, that we must be convinced of the original development of four intermediate maxillæ in mammals. It is also extremely probable that the endo-gnathion proceeds from the inner nasal process of the frontal process, and on the contrary, the meso-gnathion from the outer nasal process of the frontal process, and that only when the inner and outer nasal processes grow together, do the endo- and meso-gnatha unite. Hence the morphological value of the lateral maxillary fissure is not that of a fissure between the inner nasal process of the frontal process and the superior maxillary process, but it is the lateral maxillary fissure, the unaltered primitive fissure between the inner and outer nasal processes of the frontal process. That is to say, the lateral maxillary fissure is the result of the union of the outer nasal process of the frontal process with the superior maxillary process, but the union of the outer and inner nasal processes is lacking. We should have, therefore, in mammals eight maxillæ.

4. HUNT makes an analysis of the statements, on the subject under consideration, as made by Moldenhauer, Urbantschitsch, Gruber and the reviewer, and compares them with his own very complete publications.

5. ELLIOT COUES says that the ear of the Blarina Brevicauda may be compared with the human ear if the lobule were wanting and the pinna were folded in such a manner that the concha occluded the entrance of the meatus. Of course we must imagine the posterior surface of the auricle as covered with hair.

6. BRUNN'S experiments are intended to disprove Exner's

opinion that the branches of the olfactory nerve terminate in a loosely aggregated, protoplasmic net-work lying under the epithelium, from which the different cells of the epithelium are produced. Brunn, on the other hand, confirms and elaborates Babuchin's theory that the branches of the nerve pass directly into the epithelium. Brunn thinks that the membrana limitans olfactoria is composed of two parts: 1. The well-known ciliæ of the olfactory epithelium, and 2. A cuticle lying underneath the ciliæ and covering the epithelial cells. The latter has certain protuberances, corresponding to the edges of the epithelial cells, which lends its surface a net-like appearance. It also has parts which are surrounded by enlargements, through which the processes of the olfactory nerves protrude, to terminate near the plane of the free extremities of the ciliæ. The olfactory nerves, after many subdivisions in the mucous membrane, pass into the epithelium and then suddenly turn in a horizontal direction; they then subdivide, at an acute angle, till they terminate as minute fibrillæ.

IV.—PATHOLOGY AND THERAPEUTICS OF THE EAR

By A. HARTMANN, Berlin.

GENERAL.

1. Dr. Ladreit de Lacharriere. The utility of mineral waters in the treatment of diseases of the ear. *Annals des malad. de l'oreille*, No. 3, 1879.

2. Dr. Thomas Barr. Value of the tuning fork. *Glasgow Med. Journ.*, vol. xi., No. 10.

3. Dr. David Coggin, Salem, Mass. A new method of determining uni-lateral simulated deafness. *Archiv. of Otol.*, vol. viii.

4. Gustav Brunner, Zurich. The doctrine of subjective tinnitus aurium. *Archives of Otol.*, vol. viii.

5. Dr. v. Bremer, Copenhagen. A case of tinnitus aurium, perceived objectively. *Monatsschr. f. Ohrenhlkde.*, No. 10, 1879.

6. Dr. E. L. Holmes, Chicago. A case of objective tinnitus aurium. *Arch. of Otol.*, vol. viii.

7. Prof. Th. Leber, Göttingen. Keratomycosis aspergillina as a cause of Hypopyonkeratitis. *Gräfe's Arch. für. Ophthalm.*, vol. xxv., part 2.

8. Dr. A. GARDINER-BROWN. Asyntrophy of the right temporal bone. *Lancet*, Nov. 8, 1879.

9. Dr. ANDERSON. Clinical remarks on a case of syphilitic paralysis of the sixth pair of cranial nerves. *Glasgow Med. Journal*, vol. xi., No. 6.

10. Dr. ARTHUR HARTMANN, Berlin. Brief notes on the diseases of the ear met with in typhoid fever. *Archives of Otol.*, vol. viii.

11. EUGENE FRÄNKEL, Hamburg. Contributions to the pathology and pathological anatomy of the ear. *Archives of Otology.*, vol. viii.

12. DR. OTTO KAHLER and DR. ARNOLD PICK. Contributions to the pathology and pathological anatomy of the central nervous system. *Leipsig*, 1879.

13. M. COLDEFEY. The education of deaf-mutes. *Annal. des mal. de l'Oreille*, No. 3, 1879.

14. Prof. M. BENEDICT, Vienna. A suggestion to enable deaf persons to acquire the ability to understand speech; an open letter to otologists. *Wiener Med. Presse*, No. 42, 1879.

15. WILLIAM A. MCKEOWN, Belfast. A new acoustic apparatus, and increased sound as a therapeutic agent. *Brit. Med. Journ.*, July 5, 1879.

16. Prof. E. DE ROSSI, Rome. First year of instruction in diseases of the ear; statistics, clinical observations during the year 1878-79. *Rome*, 1879.

17. Dr. JAMES RUSSELL. A case of ear-sneezing. *Brit. Med Journal*, Aug. 13, 1879.

18. Dr. F. M. PIERCE, Manchester, Eng. The telephone and diseases of the ear. *Brit. Med. Journal*, Aug. 2, 1879.

19. Dr. WEBER-LIEL, Berlin. On intra-tympanic injections in catarhhal affections of the middle ear. *Brit. Med. Journ.*, Sept. 6, 1879.

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1. LADREIT DE LACHARRIERE begins with the remark: "No organ is more subjected to chronic diseases than the ear, and the influence of diathesis manifests itself nowhere so markedly." The question is why do not transient, accidental influences take a correspondingly short course when affecting the ear? The author is of the opinion that the reason for this is because the primary local affection is complicated by the diathesis present.

In this case a simple local treatment will always be found to be wanting in good effect. In every affection of definite duration, search should be made for the diathesis at bottom, *i.e.*, scrofula, gout, rheumatism, herpetism or syphilis. The treatment applied for these are of wonderful efficacy, notably the mineral waters.

In hydro-therapeutics, everything which tends to produce internal congestions should be avoided. Cold water and sea baths are apt to aggravate labyrinthine and catarrhal affections. They should only be employed if the reaction is sufficient. If baths or douches, of short duration, and followed by careful friction, are taken, there is very little danger.

The strong sulphurous springs are especially recommended for scrofulous or syphilitic otorrhœas where there is diseased bone, and several cases are reported in which the waters of Barèges were of wonderful efficacy. If the bone is not affected, the milder sulphur waters may suffice. The arsenical waters of Bourboule and others are serviceable in scrofulous affections where the mucous membrane and lymphatic glands are involved. The alkaline springs have been very efficacious in the author's hands in middle ear affections dependent upon the gouty diathesis. This is said to manifest itself in the form of a hyperæmic swelling of the chain of ossicles which is visible on the handle of the malleus, while the membrana tympani is unaffected.

At a later stage this hyperæmia disappears, and the malleus seems to be enveloped in a fibrous covering. This condition can also be improved by the judicious use of the mineral waters.

5. BREMER had a boy under his care in whom he observed a distinct, short, crackling, irregular tinnitus, which occurred 100–150 times a minute, and was audible at a distance of ten feet. The boy was able to produce and suspend this sound at pleasure, without any perceptible movement of the buccal or pharyngeal muscles. The noise was also heard if a catheter was introduced into the Eustachian tube. There were no alterations in the membrana tympani. The author considers that it was probably due to contraction of the intrinsic muscles of the ear, especially the tensor tympani.

7. LEBER says that heretofore aspergillus has only been found on the drumhead, in the lung and on the skin ; but he states that he has also found that it was the cause of a case of hypopyon-keratitis which was under his care.

8. GARDINER-BROWN has observed the following malforma-

tion: The right external ear, with the exception of a trace of the lobe, was wanting. The external auditory meatus could be felt underneath, its opening being covered by the soft parts. The right cheek appeared to be less developed than the left; the two rows of teeth were not on the same plane, but at an acute angle to each other. The right half of the lower jaw was higher than the other, probably owing to an imperfect development of the glenoid fossa. In contradistinction to atrophy, Mr. Gardiner-Brown calls this condition asyntrophy.

9. ANDERSON reports a case in which the patient was suffering from diplopia, as well as pain on the left side of the head, the ear and the eye. Four months previously a prickling sensation in the face and difficulty of hearing became manifest. An examination revealed paralysis of the external rectus, slightly diminished sensibility of the skin on the chin, binaural deafness with opacity of the drumhead. The tuning-fork is heard better on the forehead than in the region of the ear. Anderson diagnosticated disease of the middle ear as well as a syphilitic affection of the base of the brain or the skull on the left side. Treatment consisted of the iodide of potassium.

12. KAHLER'S and PICK'S investigations are very interesting. and from these we glean the following:

Although Wernicke was the first to express the opinion that the central terminus of the acoustic nerve and the centre of the sound images, especially as far as aphasia is concerned, lay in the first temporal fissure, and that an affection of this may be considered the cause of sensory aphasia (Kussmaul), the investigations of Ferrier and Munk proved that a destruction of the temporal lobe caused a destruction of the reaction to sound.

The notes of two cases are given, which go to establish the correctness of Wernicke's opinions.

The first was that of a woman, aged 42 years, in whom, according to the statements of her friends, loss of voice and hearing became manifest after suffering from headaches for three months. The only intelligible words which the patient could utter at the time of her admission into the lunatic asylum at Prague were, "tscheu," "tscho." On being questioned, the patient nodded, which seems to prove that she heard; the purport of the questions, however, was not understood. At the *post-mortem* a colloid degeneration of the temporal lobes of both sides was found, more marked on the left than on the right side; moreover, the poste-

rior half of the left third frontal convolution was also affected.

In the second case there had been a hemiplegia, which had disappeared. There were still distinct symptoms of atactic aphasia (subparalytic condition of the tongue), and in spite of normal hearing, an inability to distinguish words.

Some words were not understood and orders only carried out when accompanied by appropriate gestures. *Post-mortem* revealed pachy-meningitis hemorrhagica, by which the left temporal lobe as well as the third frontal convolution had been compressed and had become degenerated.

The difficulty in speech in both cases is called motor (Wernicke) or atactic, (Kussmaul) aphasia, caused by disease of the third frontal convolution.

The sensory aphasia or inability to distinguish words is attributed to the disease of the temporal lobe.

13. COLDEFEY in continuation of his last reports which have already been discussed in these ARCHIVES (vol. viii., pag. 333)* enumerates the difficulties which attend the attempt to teach deaf-mutes the art of distinct articulation. He says that great care should be exercised in the selection of pupils, and that only great skill and perseverance on the part of the teacher, who should be thoroughly conversant with the structure of the vocal organs, will make it possible to achieve success. Only ten children ought to be instructed at one time. Coldefey recommends that while at home, the children should be taught the alphabet at an early age by the parents, and praises Grosselin's phonomimie.

We think that instruction accorded deaf-mutes by their parents or their co-education with children in possession of all their faculties will rarely be attended with success.

Coldefey finally thinks it strange that a deaf-mute whom he had an opportunity to observe and who was instructed at a German institute where gestures were excluded, communicated with other deaf-mutes by gestures, but we must call M. Coldefey's attention to the fact that a deaf-mute who wishes to express himself to one who is not able to speak, can only use the common language for all deaf-mutes, the language of gestures.

* In my last report the *Gazette des Hôspitaux*, Aug., 1874, was erroneously quoted, while praising the method of instruction employed in France. The criticism of Fournier therein contained, in which he condemns the method used, can be found in my work "On deaf-mutism and the education of deaf-mutes," Stuttgart, 1880, pag, 176.

14. BENEDIKT expresses his astonishment in an open letter addressed to the Otologists, that professionals were never struck by the idea to give those who have become deaf at an advanced age, the same advantage of education which have long been enjoyed by those born deaf or who have become so at an early age, *i.e.*, to teach them the understanding of words by the observation of gestures. We may have to admit that some books of otology fail to call attention to this substitute for hearing in cases of very marked deafness, but we must also mention the existence of a special Monograph published in German and French by Schmalz. "The appreciation of lip movements as a substitute for hearing in deaf persons." Dresden, 1841.

Benedikt also appeals to the otologists, and asks their attention to the condition of the brain in post-mortems of deaf mutes, because Ferrier believes to have found the seat of cortical function of hearing in the temporal lobe. To prepare the brain for examination, it is sufficient to soak it in absolute alcohol for fourteen days and then to put it into a two per cent. solution of bichromate of potash after the meninges are removed, and leave it there for fourteen days.

15. MCKEOWN explains the better hearing of a loud noise, by the fact that the stiffness of the parts must first be overcome by strong vibrations, which will then enable them to follow even the weak impulses of the human voice. He thinks that the ear affected with a high degree of deafness, and not receiving the common impressions of sound, will become still worse if it is not exercised in its functions. To prevent this, the person who hears with great difficulty ought to be enabled to use his ear for several hours every day. McKeown thinks the common ear-trumpets unserviceable, and uses two large funnel-shaped tubes with a soft mouth-piece. The tubes are to be fastened to both sides of a chair in a changeable position. McKeown considers binaural hearing of great importance. The apparatus is said to have not only advantages for daily use, but that it also improves the sense of hearing. A man of seventy-one years of age, who could hear only very loudly spoken words close to his ear, was said to be able to hear after one session, of a few minutes, at a distance of 2′–4′, and after several sessions at a distance of 6′–8′.

16. DEROSSI lays great stress in the beginning of his yearly report upon the fact, that a new era for Otiatry in Italy, and especially at Rome has begun with the collegiate year of 1878—

79, as a hospital dispensary for ear diseases has been established at Rome. 364 patients were treated in the current year.

Among those cases which deserve a special attention, DeRossi mentions one of myringitis acuta, attended with violent pains, which was cut short by an instillation of alcohol. In another case of acute myringitis he observed a blood cyst on the membrane tympani. The same was perforated and no connection with the cavity of the tympanum found. A neuralgia tympanica in consequence of malaria was cured by quinine. A neuralgia which appears several times daily since three months, was cured by the extraction of a tooth. In the second half of the report, the author speaks of the cases which were treated at the Otological Clinique. An opening of the mastoid process was undertaken in eight cases, two of which ended fatally, one by septicæmia, and the other by meningitis and abscess of the cerebellum. Further the externally healthy mastoid process of a patient who had a grain of oats in his ear, was opened with good result, after he has suffered from a great swelling of the auditory passage and the most violent headache.

17. RUSSEL describes a case of ear sneezing occuring to a man of 56 years of age, of a very nervous temperament, who was suddenly affected by yawning and sneezing. The sneezing continued uninterruptedly for the next two days and one night. After a violent attack of sneezing, the patient fell senseless to the floor and remained so for 2–3 minutes, then complete deafness on both ears and a beating noise set in. No sign of coughing and dizziness. Both the membranæ tympanorum were inflamed during the examination. To explain these symptoms, Russel refers to the anatomical connection between the vagus and trigeminus, proved by Lockart Clarke in ear-coughing. Russel believes that the sudden change in the middle ear (acute inflammation), affected the heart by the inhibitory influences of the vagus and caused unconsciousness.

18. A woman listening through a telephone, which was led through a wire, during a thunder-clap, was affected with syncope and deafness, accompanied by a feeling of dizziness. nausea and tinnitus. These symptoms with the exception of the deafness disappeared after a few minutes. After fourteen days the normal hearing was restored.

19. WEBER-LIEL remarks that after an experience of sixteen years, he is convinced that injections have no effect in chronic

middle-ear catarrhs. If the catarrh extends from the Eustachian tube and from the naso-pharynx, strong injections of a solution of lunar caustic must be used. In collapse of the tube walls, intratubal galvanization is recommended. Weber-Liel uses also in cases of mucous and adhesive catarrh a solution of soda for injection into the cavities of the tympanum in connection with air-douche.

ABSTRACT OF AMERICAN OTOLOGICAL LITERATURE.

FOR THE FIRST QUARTER OF 1880.

By SWAN M. BURNETT.

1. *On affections of the ear arising from diseases of the teeth, by S. Sexton, Amer. Journ. M. Sci., Jan.*

The author makes the assertion at the outset that he finds of "fifteen hundred (recorded) aural cases, perhaps one-third owe their origin or continuance in a greater or less degree, to diseases of the teeth." This statement, if it could be positively established by statistics, would indeed be a valuable contribution to aural pathology, but either from want of space or other cause, Dr. S. fails to give any support of this kind to his assertion. In order to arrive at the true value of dental influence on affections of the ears, we must have, not only the number of aural cases in which are found dental troubles, but also the proportion of the general population who have dental troubles without aural complications, and until we have some such statistics, mere isolated cases can have but an unimportant significance, particularly where the morbid influence is exerted through the circuitous and ill-understood process of reflex action.

Dr. S. gives the latest theories in regard to the process of reflex action, and proceeds to apply them to the connection he wishes to establish. He speaks at length of the first and second dentition of children and the caries and necrosis of adults and the irruption of the wisdom teeth.

That the irritations produced by these processes can be and and are, relatively often, felt at remote parts no one will, we presume, deny, but that they play the important part in the production of the local diseases (mostly inflammatory) of the middle

and external ear, which Dr. S. claims will, we think, require years of observation and the exclusion of other morbid processes whose connection with these troubles is much more direct and easily understood.

Dr. S. then proceeds to array the dental profession in a mass before the bars of justice and lays the origin of much trouble at their door, which, however, is of a general character, and only effects the ears secondarily. We do not, therefore, feel ourselves competent to deal with this part of his subject, and will add some observations on Dr. S.'s paper by Prof. Hodgkin to be found in the *Amer. Journ. of Dental Science*, for Feb.

He says the "Dr. S. certainly betrays the lack of accurate knowledge of the subject, possibly possessing as much as most men outside the practice of dentristry, but assuredly not enough to justify the assertions he makes or the conclusions he arrives at." He says further that "the amalgams in common use are not composed of tin and silver mainly as Dr. S. asserts," and in reference to the toxic effects that Dr. S. says may result from attention to these fillings, Dr. H. says that it is now clearly established that "the combination between the finely divided metals and the mercury is exceedingly close and only separable by the action of a high temperature (nearly red heat) or the action of acids so energetic as to attack the alloys themselves." In regard to the amount of attention he says that "an ordinary amalgam filling would lose the $\frac{1}{1000}$ part of its weight in a year," and adds that "it is not true that amalgam fillings have the effect to weaken the enamel."

Finally in regard to the hidden dangers of the vulcanite plate on which Dr. S. dwells, Dr. H. quotes from Makin's standard work on metallurgy that "neither water, alcohol, the alkalies, nor the mineral acids singly have any effect on vermillion," which is the dangerous element in the composition of the plate in question. In conclusion Dr. H. affirms that the only recent accepted authority quoted by Dr. S., is Dr. Abbott.

2. *Clinical remarks upon diseases of the internal ear, by D. B. St. J. Roosa. St. Louis Med. and S. J., Jan. 5th.*

Dr. R. points out the means of making a differential diagnosis between middle ear and nervous deafness. These are: 1st, by exclusion of middle ear trouble; 2d, the tuning-fork; 3d, the piano, the nervously deaf hearing the upper tones much worse than the lower; 4th, the suddenness of attack; 5th, painfulness to certain sounds; 6th, not hearing better in a noise.

Nothing is said of treatment except when syphilis is the cause, that the energetic use of mercury and iodid. potas. is frequently followed by happy results.

3. *A case of reproduction of the membrana-tympani, by S. O. Richey. Amer. Jn'l Med. Sci., Jan.*

Thirty-five years before, the patient had purulent inflammation of left drum cavity. There is now loss of *M. T.* entire, except a small segment 0.5 *mm.* broad at lower inf. quadrant, and there are granulations of the mucous membrane and a polypus. They were removed, and the ear treated daily with argt. nit. ʒ i to ʒ i, after cleansing with alkaline solution, by way of the Eustach. tube. A new memb. was formed, the tissue advancing from all sides toward the centre. Treatment lasted about nine months. Hearing power increased from $\frac{1}{3}\frac{1}{6}$ to $\frac{8}{3}\frac{5}{6}$. R. thinks the new membrane was not cicatricial tissue, but a true membrane. We, however, coincide with the opinion of Moos, that these new membranes are not, in the strict sense of the word, reproduction of the *M. T.*, but are cicatricial.

4. *Otorrhœa, by J. A. White. Va. Med. Monthly, Jan.*

A résumé of our knowledge of the subject, and some cases.

5. *Children's earache, by C. J. Blake. Bost. M. and S. Jn'l, Feb. 5th.*

In the early stages of the acute middle ear catarrh of children, before the pain is severe, B. advises gentle inflation of the middle ear,—just enough to allow any accumulation of fluid to escape into the throat. When the disease has progressed farther, and the pain is more intense, he punctures the *M. T.* for the purpose of giving an exit to fluid in that direction. A bit of absorbent cotton is then introduced to take up the discharge, and syringing and lotions are to be used only after the pain has disappeared and the discharge is more profuse and purulent.

Dry warmth can be applied externally. He advises against moist warmth.

In the discussion of this paper in Suffolk Dist. Med. Soc., Dr. Herot thought the pain in such cases came, not from an increase of the intra-auricular pressure, but from the inflammation of the *M. T.*, and that the relief offered by puncture was due to the unloading of its vessels.

6. *The mastoid region and its diseases, with illustrative cases, by L. Turnbull. St. Louis M. and S. J., Feb. 20th.*

This paper is too long to condense into an abstract which would do it justice. It is a careful study of the anatomy of the mastoid

region in children and adults, with its pathology and treatment. Ten cases are given in illustration. The last one is of special interest, as being a "form of mastoid periostitis as undescribed by otological authorities," and first mentioned by Voltolini. It is, according to Dr. T., a disease "neither of the auricle, external auditory canal, the tympanic cavity nor mastoid cells, but that it originates without and not within the ears." Of this disease Knapp, Blake and others have recorded cases, and the reporter relates one in this number of the ARCHIVES.

7. *The audiphone and other instruments to assist impaired hearing (deafness), by C. S. Turnbull. M. and S. Rep., March* 20.

Dr. T. records his experience with the audiphone as decidedly unsatisfactory, annd attention should be directed to the construction of instruments which *reflect*, and thus intensify rather than *conduct* the sonorous vibrations to the nervous apparatus.

8. *Case of sympathetic otitis, by E. A. Cobleigh. Cin. Med. News, March.*

C. reports one case of a man who had a severe and obstinate acute catarrh of the middle ear of one side, which he considered as due to the irruption of the wisdom tooth on that side, the more especially because, when the wisdom tooth on the opposite side was irrupting, symptoms of inflammation on that side set in, which were abated by free incisions over the offending tooth. He reports another case of a lady who had an annoying tinnitus without any assignable cause, who was relieved of her trouble by the extraction of a painful molar on the lower jaw. C. had evidently read Dr. Sexton's paper, though no mention is made of the fact.

9. *The anatomy and surgery of the Eustachian Tube, by Arthur Mathewson. Annals Anat. and Surg. Soc.* (Brooklyn), *March.*

An interesting paper, giving a résumé of our knowledge of the anatomy and physiology of the Eustachian tube, as well as its pathology and treatment.

20. In the same number of this journal we have a biography by G. J. Fisher of Bartholomeo Eustachio, the discoverer of the tube called by his name, to which is added a bibliography of his works.

11. *Foreign bodies in the eye, by M. A. Amick. Cin. Med. News, Jan. and March.*

A general consideration of the subject, with reports of cases in illustration.

12. *On disease of the mastoid process, by H. Knapp. Trans. Amer. Med. Ass.*, 1879.

Dr. K. considers inflammations of the mastoid under four heads. 1, External primary; 2, external secondary; 3, internal primary, and 4, internal secondary.

The names indicate at once their pathology. The first form is rare. He has never seen a case of the third kind, but the fourth variety is common. Two illustrative cases of this are given, and the indication for opening the mastoid process in such cases are plainly laid down. If there is persistent headache in spite of free discharge, or if the discharge has suddenly ceased without abatement of other symptoms, opening of the mastoid is imperative.

13. *Operation for mastoid disease, by A. Blitz. Trans. Amer. Med. Ass.*, 1879.

A case of secondary mastoid inflammation in which the mastoid was opened and pus let out, though there was no redness nor swelling, but pain in that region.

14. *Report on otology, by H. Knapp. Trans. Amer. Med. Ass.*, 1879.

A synopsis of the work done in the field of otology for the past year, including some very excellent practical remarks on the indications for opening the mastoid.

NOTICE.

THE SECOND INTERNATIONAL OTOLOGICAL CONGRESS will be held at Milan, Italy, from Sept. 6th to Sept. 9th, this year.

Committee of Arrangements.

Prof. VOLTOLINI, of Breslau, Germany, *President*,
Prof. MOOS, of Heidelberg, Germany, *Secretary*.

THE SIXTH INTERNATIONAL OPHTHALMOLOGICAL CONGRESS, will be held in the same city, Sept. 1st to Sept. 4th.

Fig. 3

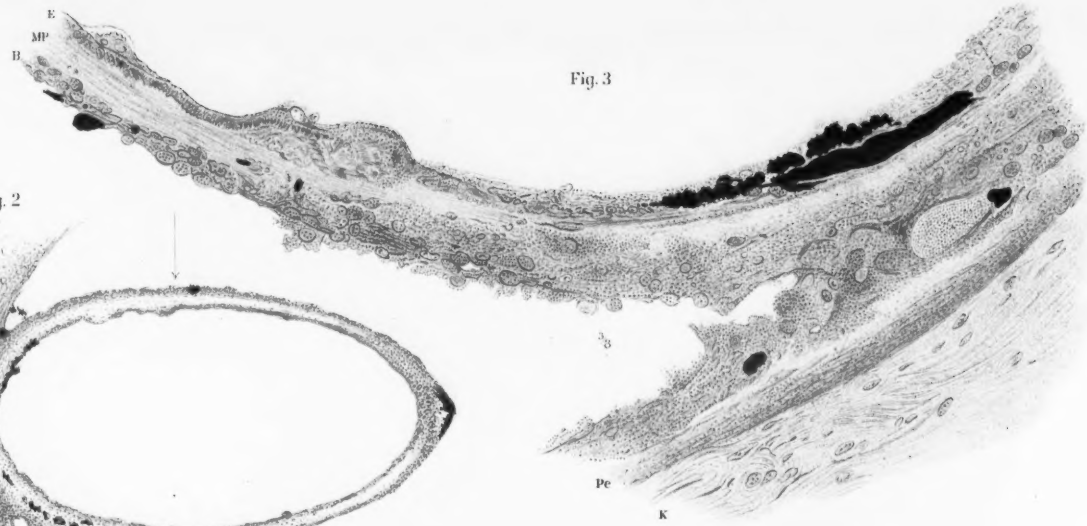


Fig. 2

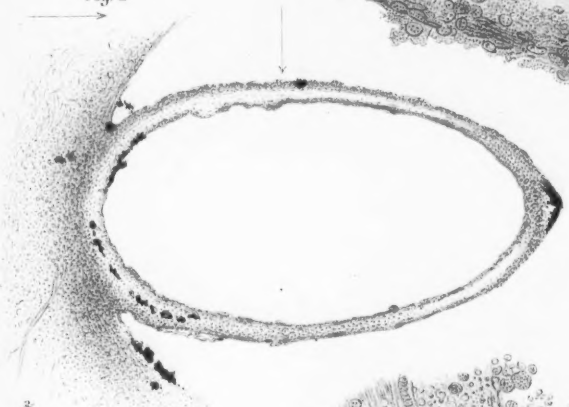


Fig. 8

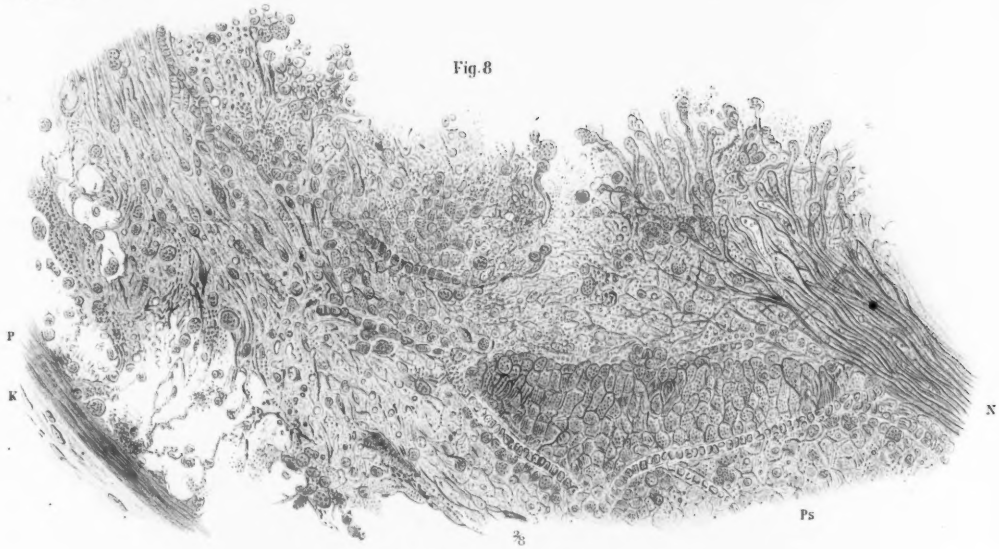
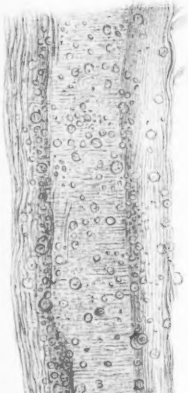


Fig. 15



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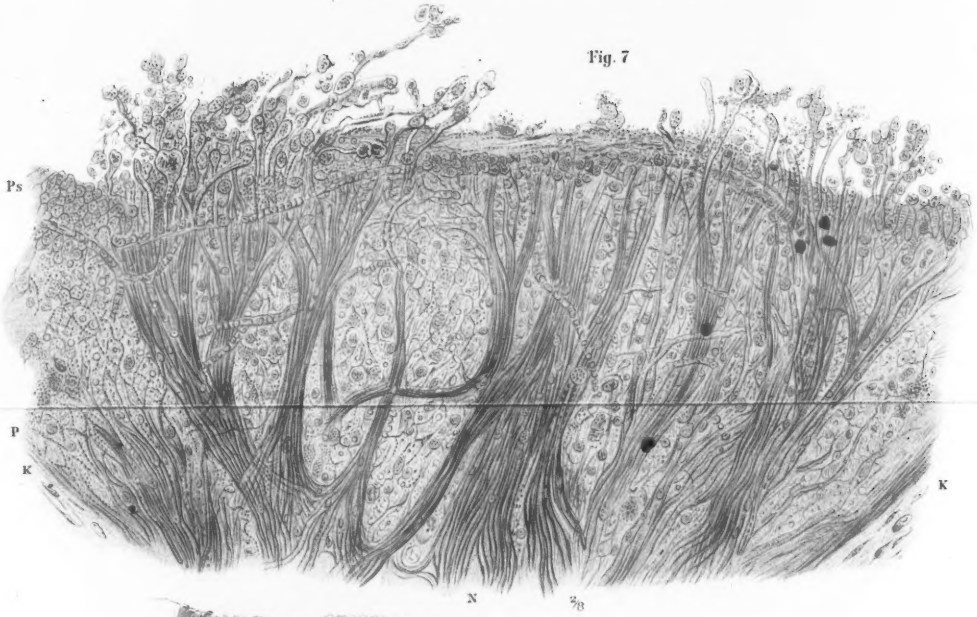
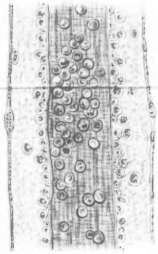


Fig. 16



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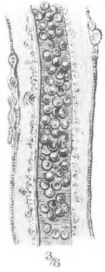
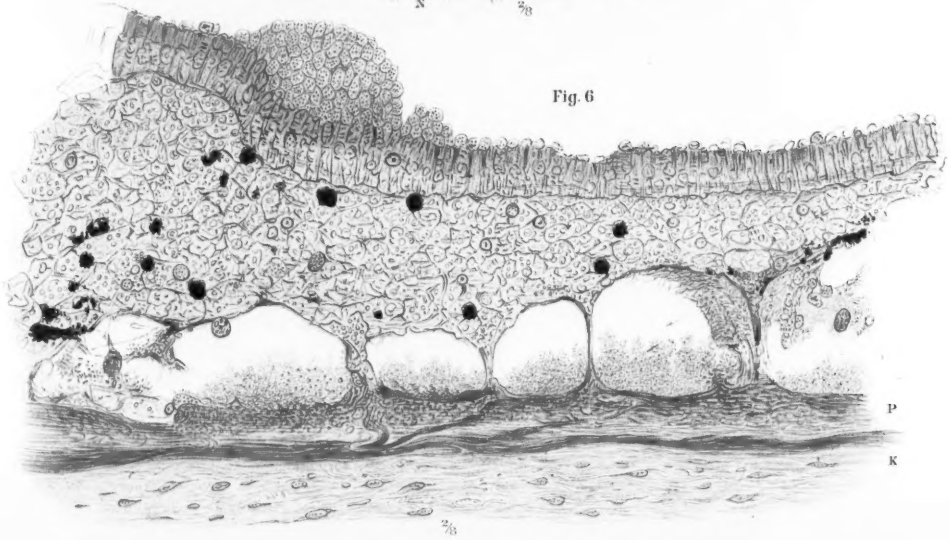


Fig. 6



Tab I.

Fig. 1

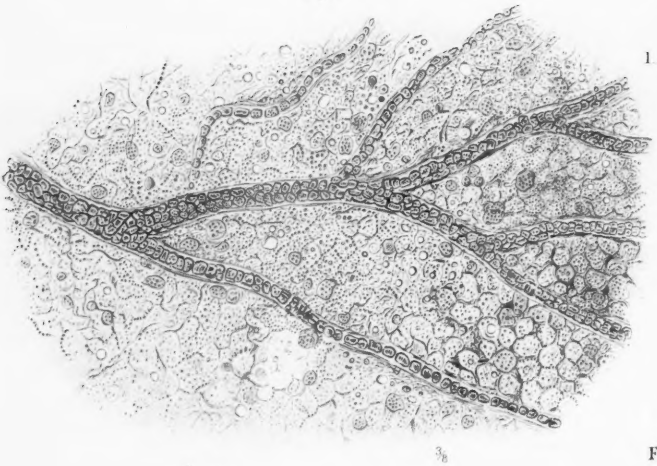


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Fig. 13

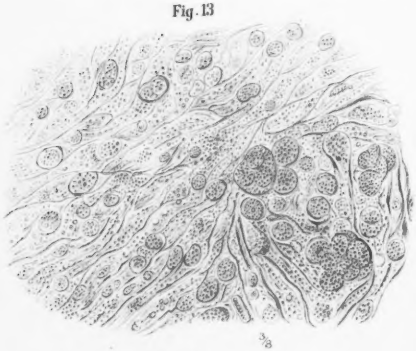

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Fig. 14

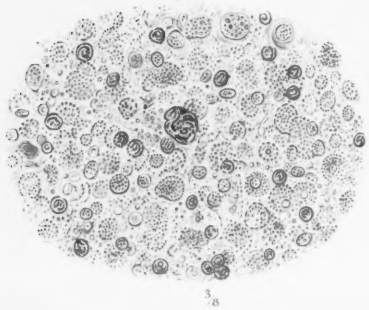

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Fig. 23

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Fig

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Fig. 24

Fig. 18

Fig. 25

Fig. 19

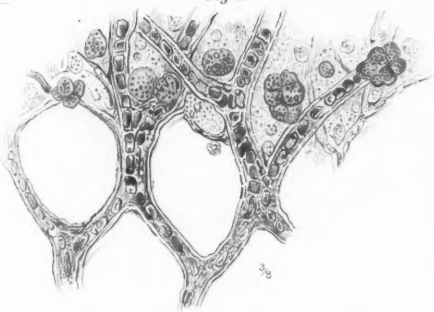

Fig. 11

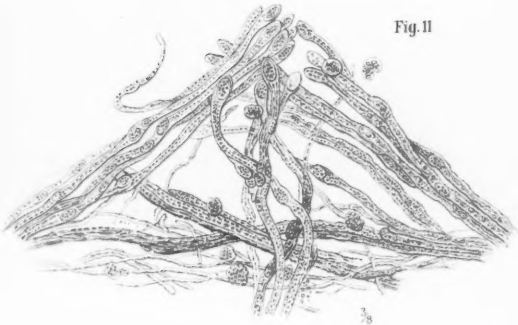

Fig. 9

Fig. 5

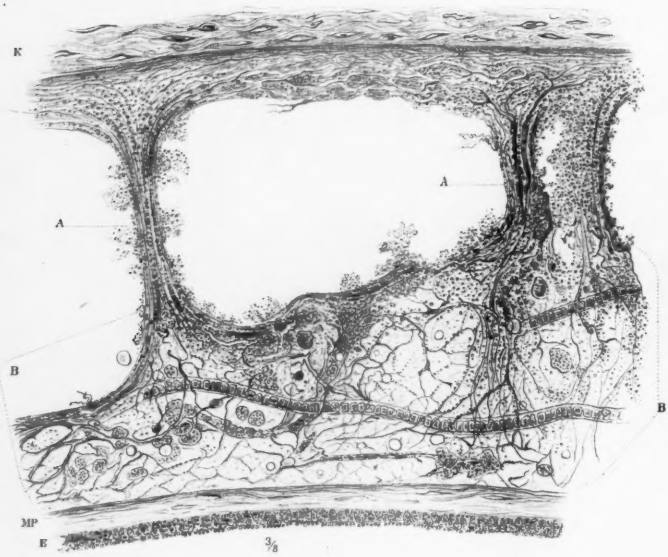

Fig. 4

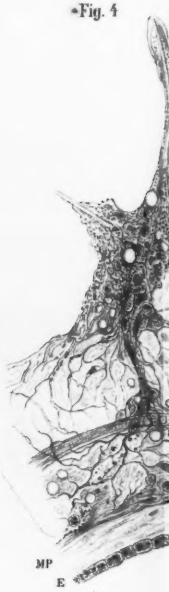

Fig. 21

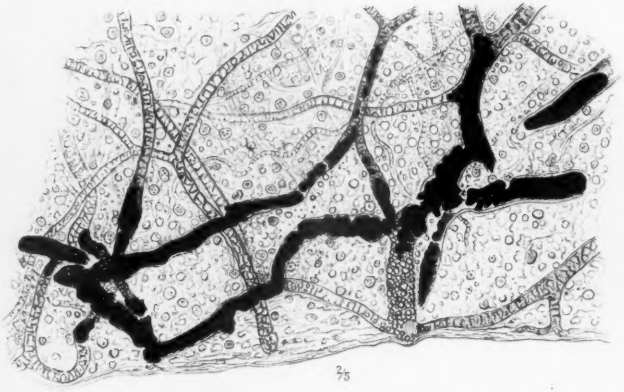

Fig. 10

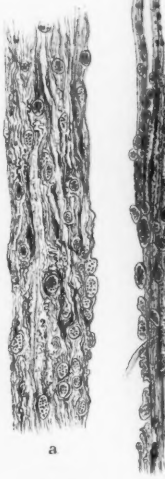

Fig. 4

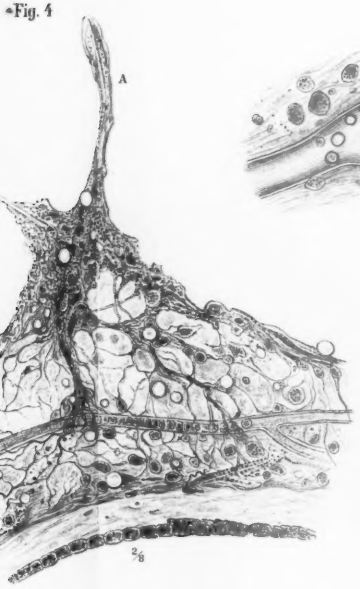

Fig. 20

Fig. 12

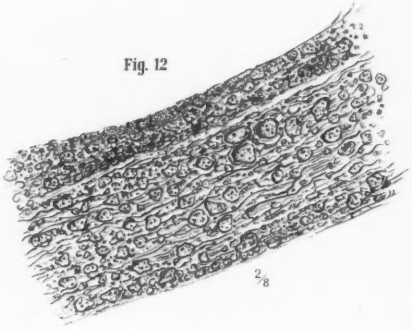

Fig. 10
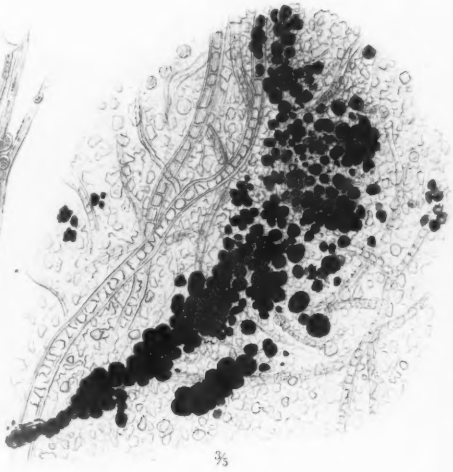
Fig. 22